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The Problem of the Unrestored Television Receiver

By ROBERT J. NISSEN

It is maintained that correct gray-scale reproduction is the most important parameter of television picture fidelity. Under certain picture conditions, the absence of d-c restoration in the modern home receiver will almost totally destroy proper gray-scale reproduction. Set manufacturers were queried as to their reasons for excluding this critical circuit. To compensate for the unrestored picture, until restoration circuits are again included in the home receiver, operating procedures and standards based on the use of the transmission waveform as a guide are proposed.

TELEVISION broadcast engineers are acutely aware of the vast difference in quality between the transmitted signal and the one the home viewer finally sees. Though some of the causes of this difference in quality originate in the transmission system, at least one, the picture degradation caused by the lack of d-c restoration in the average home set, does not.

Figures 1A and 1B show the difference between a restored and an unrestored system. These are composite pictures taken from the face of the same monitor tube. The left portion of each Figure was taken with d-c restoration: the right portion without it. There were no changes in either television or photographic parameters except for d-c restoration. The resolution of the picture used to illustrate this paper was purposely restricted to about 3 mc in order to approximate the bandpass of the average home receiver.

What happens to cause this picture degradation when the d-c restorer is eliminated from the monochrome receiver? The end result can be described this way: *The brightness values of the gray scale on the picture tube will vary in proportion to the area of the various shades in the original picture.* The importance of the d-c restorer grows out of the generally accepted fact that proper gray-scale rendition contributes more than any other factor to the quality of a television picture. It is by light and shade and dark that we tell the shape, the texture, and the quality of objects.

Presented on May 6, 1960, at the Society's Convention in Los Angeles by Robert J. Nissen, KQED, 525 Fourth St., San Francisco 7.
(This paper was received in final form on July 20, 1960.)

The Gray-Scale Parameter

The importance of the gray-scale parameter was convincingly demonstrated several years ago with the introduction of the video-tape recorder. The industry was thoroughly impressed by the quality of a video-tape recording — not because of its resolution (a good kinescope recording then and now can have a greater resolving power) — but because of the accurate gray-scale transfer characteristics.

Gray-scale fidelity in the television system might well be compared to low linearity distortion in an audio system. Subjectively, linearity distortion in a reproduced sound is far more objectionable than a limited frequency response. In a similar manner, gray-scale distortion appears to be a far more important parameter in television quality than resolution capabilities.

The brightness control on the monitor from which the pictures in Fig. 1 were taken was adjusted in exactly the same manner for both the restored and the unrestored portions. It was set to reproduce the standard EIA test pattern

Fig. 1A. Pictures taken from same monitor tube, first with d-c restoration (left) and then without d-c restoration (right).

Fig. 1B. Pictures taken in same manner as Fig. 1A with d-c restoration (left) and without d-c restoration (right).

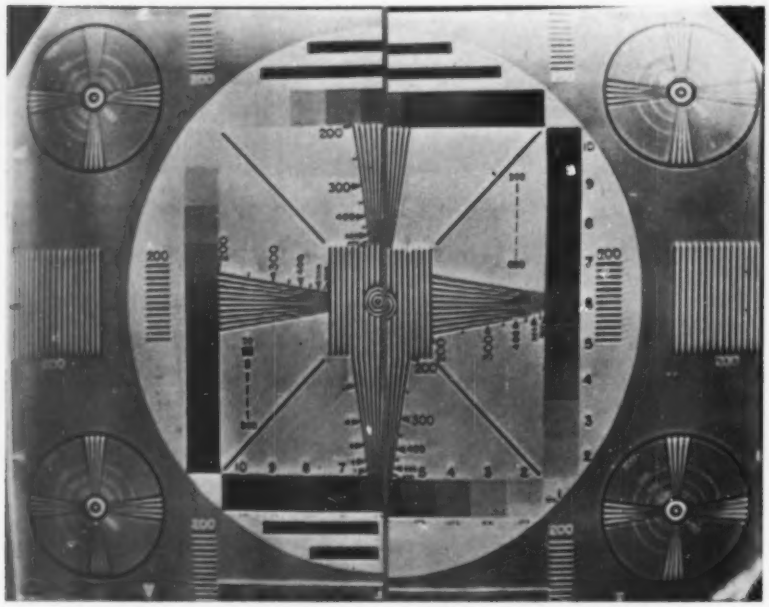


Fig. 2. Balanced area test pattern, d-c restored (left), and unrestored (right).

with equal gray-scale fidelity. Figure 2 shows this comparison. The left side of the picture is once again restored, whereas the right is unrestored. As can be seen, there is no difference between the restored and unrestored test pattern.

However, when a picture composed of an unbalanced gray scale, such as Fig. 1, is fed to the kinescope, there is a great difference between the restored and unrestored picture. The "blacks" are reproduced as a dirty, gray, and usually noisy background. The middle grays are lightened in value. In addition, highlight saturation almost invariably distorts the picture. This white saturation is particularly destructive of picture quality as it tends to wash out skin tones and facial detail. A face often becomes a white blob against a gray background — hardly a true or even a pleasing reproduction of the original. As Neuhauser most eloquently puts it, "a mood shot, such as a romantic moonlight walk, looks like an over-exposed picture taken by an amateur with a box camera on a cloudy day."[1]

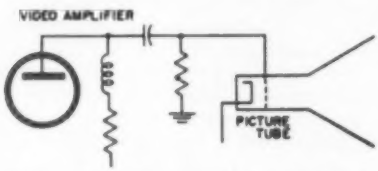


Fig. 3. Typical a-c-coupled, unrestored picture-tube circuit. (Drawings for Figs. 3–7, inclusive, Courtesy of *Electronic Industries*.)

Causes of Gray-Scale Destruction

Figure 3 shows the typical circuit in a receiver for coupling the video amplifier to the kinescope tube. Whether the picture tube is grid or cathode driven is immaterial here. A-c coupling is invariably used in video circuits for simplicity and economy. But a-c coupling cannot, of course, pass a d-c component, and the d-c component of the video signal is essential to the preservation of picture quality.

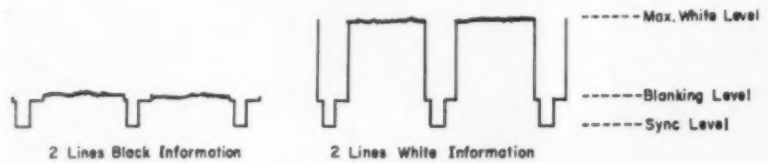


Fig. 4A. White and black video information with d-c component present.

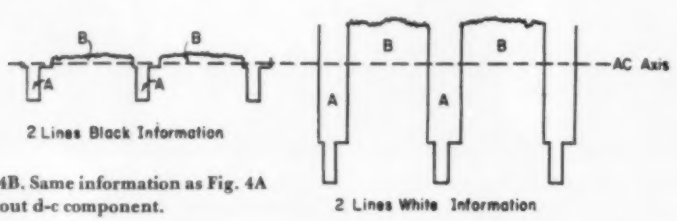


Fig. 4B. Same information as Fig. 4A without d-c component.

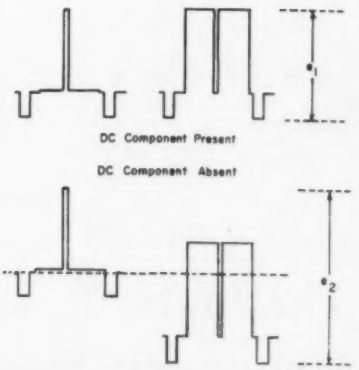


Fig. 5A (above). Dynamic range required for signal with d-c component present. Fig. 5B (below). Dynamic range required for signal with d-c component absent.

Figure 4 (A and B) shows what happens to two similar video signals under both restored and unrestored conditions. Figure 4A shows white and black video information with the d-c component present; Fig. 4B shows the same white and black video information with no d-c component. The distribution of the signal around the a-c axis is, of course, caused by the inability of the coupling capacitor to pass the d-c component. The a-c axis on any waveform of this type is that line which allows area A to equal area B. That is to say, there is no d-c component in the signal.

When the d-c component is present, as in Fig. 4A, the sync pulses and blanking levels are maintained in the same d-c amplitude relationship with each other, independent of the nature of the video information. This rigid relationship originates in the broadcast studio and is maintained by FCC regulation through the video demodulator of the receiving set.

We should now observe what happens to these relations when the signal passes through the capacitor. In Fig. 4B the two blanking levels no longer have the same fixed d-c amplitude relationship with each other. Instead, the black level, and hence the entire gray scale, floats up and down, dependent on the nature of the *picture* information.

Consider what havoc this creates with tonal values. We may adjust the "brightness" control to cause the picture tube to go black at the proper blanking level during reception of the black information lines. Then when the white information lines are received, the "white" information will be reproduced as a dark gray.

Conversely, we may adjust the "brightness" control to cause the picture tube to go black at the proper blanking level

during reception of the white information lines. When the black information lines are received the "black" information will show as a light gray.

Under these conditions the original blacks and whites at the studio are both reproduced at the home set as gray!

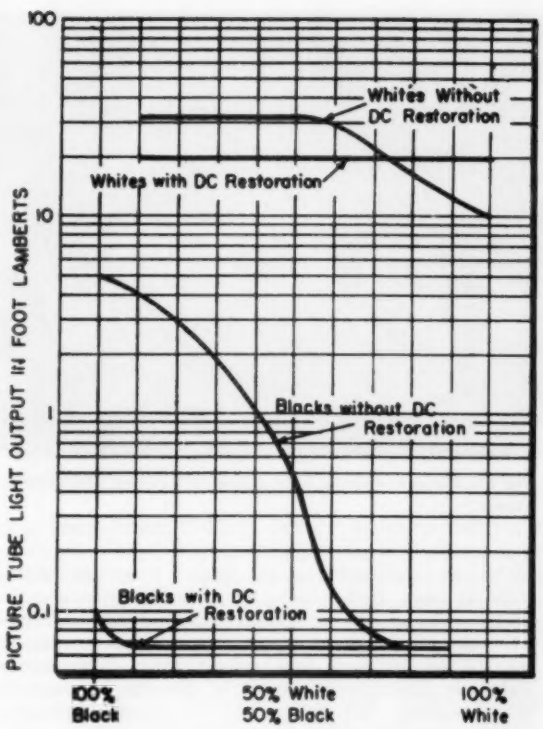
In addition to shifting gray scales, another problem is caused by the absence of the d-c component. The two extreme cases of video information are shown in Fig. 5 (A and B), namely a small white area on black background, and a small black area on white background. The signal without the d-c component has a peak-to-peak voltage almost one and a half times that of the signal with the d-c component. Consequently, for the same degree of amplitude linearity, a more expensive amplifying system is required when the d-c component is absent.

In the design of the average home receiver, this problem is usually simply ignored; therefore, the combination of the lack of the d-c component, inadequate amplitude linearity, and poor high-voltage regulation on the picture tube results in muddy blacks, pasty grays, and saturated whites.

When the d-c component is not sent to the picture tube, the brightness control is usually set to provide a pleasing picture of an average video signal. Then, so long as the succeeding pictures have a similarly balanced gray scale, they will be reproduced with tonal fidelity, *regardless of the absence of the d-c component*. It would seem to be apparent that the d-c component is of no value when a balanced distribution of the whites, grays and blacks is maintained in all the pictures transmitted. Unfortunately, normal picture information has greatly varying balances of gray-scale information. And the need to balance areas of black and white imposes a virtually impossible task upon the broadcaster. The result is that the quality of reproduction must suffer at the home receiver.

An example of this serious problem is shown in Fig. 6. The graph shows the actual light output in footlamberts on the face of a typical picture tube. Measurements were made with varying percentages of white and black picture areas under restored and unrestored conditions. A log scale is used for the light output since the eye responds to brightness in an approximate logarithmic manner. Note that the contrast ratio between the 100% black and the 100% white is only 2 to 1 under unrestored conditions, while under restored conditions it is 200 to 1.

Fig. 6. Light output from face of picture tube with d-c restoration and without. Input signals of white and black were held constant.



Methods of Preserving D-C Components

There are two ways by which the manufacturer can preserve the d-c component. The first is to utilize a d-c-coupled amplifying system. There is then no loss of the d-c component, and the gray-scale reproduction is controlled by the broadcasting station. This system has the inherent problems of any multistage d-c-coupled amplifier, namely, power supply complications and the difficulties of maintaining stable bias relations with varying circuit parameters. However, it has the considerable advantage of being unsusceptible to impulse noise.

The second method is to realign all the sync or blanking pulses to a common d-c amplitude by d-c restoration. There are two types of circuits which accomplish restoration: the peak rectifier restorer and the keyed-clamp restorer. Simplified examples are shown in Fig. 7 (A and B). Since the theory and operation of restorers are thoroughly covered in standard texts[2] they will not be treated further here.

Why is it, if there is such clear-cut evidence of the superiority of the set with d-c restoration, that of the 5,300,000 monochrome home receivers manufactured in 1958, nearly 98% did not have this circuit incorporated? During a recent survey, conducted by the author, major television receiver manufacturers in the United States were asked, among other questions, to give reasons for their policies on d-c restoration. Some of the answers were surprising in that they indicated ignorance of the effects of the lack of d-c restoration.

Certain manufacturers present seemingly valid arguments for the unrestored set. Three fairly representative statements are outlined below.

Added cost heads the list, even though it has been estimated that d-c restoration would add only 25 or 30 cents to the total cost. (This amount is about the average of the cost estimate of the various manufacturers.) This cost might increase if the manufacturer takes full advantage of the benefits of the d-c component, such as upgrading quality in the areas of AGC, high-voltage regulation, etc. This cost, however, cannot properly be charged to the d-c restorer.

The second argument offered against d-c restoration is its susceptibility to noise. A large negative pulse may tend

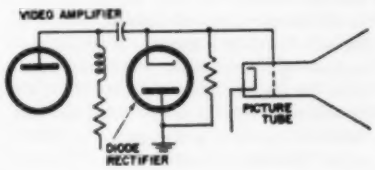


Fig. 7A. Peak rectifier d-c restorer.

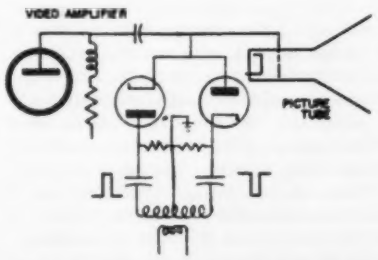


Fig. 7B. Keyed clamp d-c restorer.

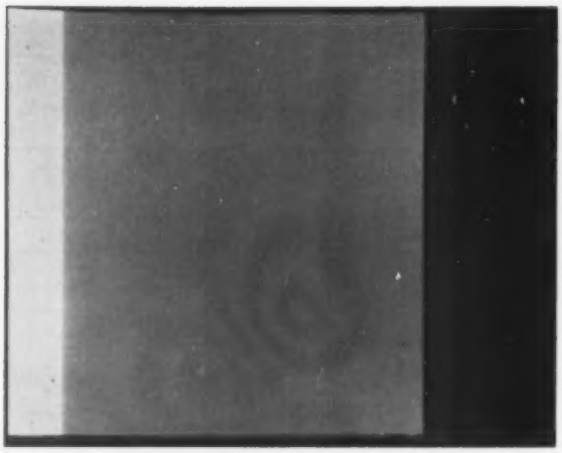


Fig. 8A. Picture of signal from standard waveform balance generator.

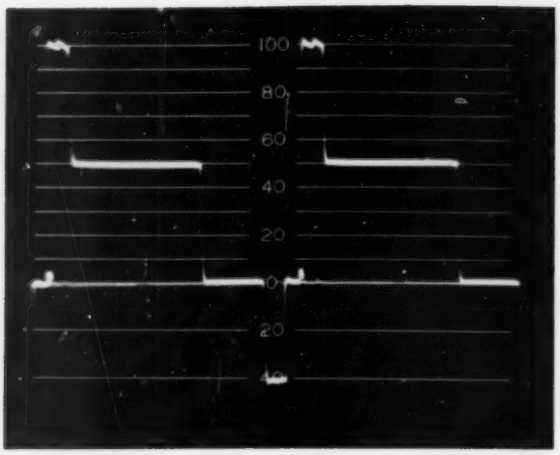


Fig. 8B. Waveform of Fig. 8A.

to be more noticeable in the picture, since it may momentarily shift the operating point of the picture tube. Years ago, the impulse noise problem of the d-c restorer may have offered a legitimate point against its use in the home receiver. But today, with the development of high-gain low-noise converter stages, improved antennas, better automatic gain control circuitry, and high-power transmitters, the "noise-susceptibility" argument has little validity. In any event, the set could certainly have a "restored-unrestored" switch for use in extreme fringe or noise areas.

Apparently the additional expense alone prohibits the use of the superior keyed-clamp form of d-c restorer, which has very good immunity to noise. The clamp pulses could easily be obtained from the fly-back voltage of the horizontal deflection circuit. The keyed clamp has its own problems with short time impulse noise, as can be attested by broadcasters who rebroadcast off-the-air signals. In many cases the clamp circuit operating on the noise information renders the signal unusable. However, this would not have to be the case with the home receiver which uses a "flywheel" type horizontal oscillator to drive the clamp. Under these conditions, noise disturbances in the keyed-clamp restorer would be virtually ignored.

The third argument offered against the use of d-c restoration is that broadcasters do not maintain proper black-level control. The complaint is that the viewer with a restored receiver finds objectionable shifts in black level when he is changing channels, or when cameras are being switched during a program. There is just enough truth in this to confuse the issue. In the early days of television, much of the broadcast equipment was incapable of generating or maintaining proper black-level information in the picture. Even though modern equipment is now entirely adequate, some stations still do not maintain sufficient control of their transmitted levels.

The solution is twofold: (1) greater appreciation by operating personnel of the importance of absolute level control, and (2) use of equipment which will automatically maintain proper levels.

No case can possibly be made that the unrestored receiver maintains proper gray-scale levels. A case can be made that an unrestored receiver so distorts black-level changes that improper operation at the broadcast station may be less noticed. However, one might just as well suggest spraying a fine fog coating on the picture tube, so that the difference between a good and bad picture is less obvious.

In the author's opinion, the argument against the restored receiver on the basis of unstable broadcast levels is invalid because, despite imperfect black-level control, the average quality is far superior on a restored receiver. The black level at the picture tube can be shown to vary as much as 60% under *unrestored* conditions,[2] whereas, even with poor broadcast control, transmission levels will seldom vary more than 10%. One has only to spend a short time in a television control room, observing both restored and unrestored monitors, to determine whether he would give up the certain advantages of d-c restoration for the dubious advantages of the unrestored set. As far as the author knows, no one who has made this test — even in the presence of improper broadcast-level control — prefers the unrestored receiver. The excellent black-level performance of the modern color set (which has d-c restoration), when used on monochrome signals, refutes the arguments based on unstable broadcast levels and noise susceptibility.

In addition to the three objections cited above, one manufacturer claimed that laboratory and field tests indicate that d-c restoration is of little or no value, but no tests are actually cited. The sources of at least similar misinformation are not too difficult to find. For one thing, sets have been selling quite well for a number of years *without* d-c restoration. Virtually no complaints have been forthcoming from the consumer. The average owner, not having facilities available for an A-B check of restored versus unrestored sets, is generally unaware of the possibility of superior quality. It is also possible that the manufacturer may be unaware of the effect of d-c restoration.

Effects in Broadcasting

What then does all this mean to the broadcaster? First, he must try to persuade manufacturers to preserve the d-c component in the receiver. This is an absolute, minimum requirement if we are to maintain gray-scale picture fidelity.

Second, as a stop-gap measure until the d-c component is no longer destroyed in the home receiver, the broadcaster must be aware of the handicap this places upon the video information. Care must be exercised in lighting, set design, scripting and staging to provide a reasonably balanced gray scale to the camera.

The a-c axis — or in lighting terms, the gray-scale balance — must not vary appreciably, if a true picture rendition is to be received in the home. Often this may be directly contrary to the artistic effect desired. The conscientious broadcast engineer, aware of these limitations, must rule out night scenes with large areas of black, small area titles on black backgrounds, limbo shots, etc. The wide capabilities of lighting and staging techniques otherwise available to tele-

Fig. 9A. Example of highly unbalanced gray-scale subject taken from unrestored monitor.

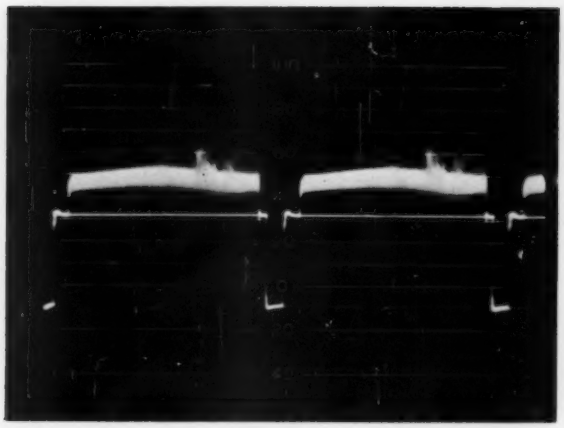


Fig. 9B. Waveform of picture shown in 9A. Unclamped blanking has shifted 32 IRE units.

vision must be restricted or modified. Many artistic effects simply cannot be permitted. The engineer knows that if they are allowed to be broadcast, the picture on the home set will be entirely different from the one on the control room monitors, which have d-c restoration. The intended effect will probably fail miserably at home.

Two suggested methods may help the engineer to determine the best staging, lighting and control practices for the unrestored receiver. The first is the obvious solution of having an unrestored auxiliary monitor in the control room. At best, this approach is subject to the limitations of subjective evaluations. Its best function — to put it in the words of one of the author's colleagues — is to "remind the programing people what the junk looks like coming back."

The second aid to the broadcaster programing to the unrestored receiver, one far more accurate and useful, is the waveform monitor. Analysis of the actual waveform of a picture on the waveform monitor, when compared to a standard, is the most valuable method of determining how the picture will reproduce on an unrestored set. When properly used, it places in the hands of the engineer a device for accurate measurement of the waveform gray-scale balance. For this use the clamp or restorer in the waveform monitor is disabled, allowing the display to seek the a-c axis. The video signal of a gray-scale balance standard is then connected to the waveform monitor.

Experiments with numerous studio pictures seem to indicate that a proportion of 10% white, 65% middle gray, and 25% black closely approximates the gray-scale balance of good set design. A signal generator was built at KQED to produce this standard waveform balance electronically. Pictures of its output from the monitor screen and the CRO are shown in Fig. 8 (A and B). Camera blanking pedestal adjusted to 40 IRE units can also be used to approximate this standard waveform balance.

With the waveform standard signal connected to the waveform monitor and its restoration circuit disabled, the vertical position of the display is adjusted to set the blanking level on the zero reference line, and it is then calibrated. The waveform monitor is then fed the signal of any picture to be judged from the standpoint of waveform balance. If this picture has the same balance as the standard, the vertical position of the display does not shift. If, however, it is different in gray-scale balance, the shift of the blanking level in IRE scale units indicates the difference of gray-scale balance. Therefore, setting go and no-go limits to unbalanced waveforms eliminates the problems caused by subjective evaluation of the picture.

Any picture which has a shift toward the black end of the gray scale (i.e., has too much dark tone area) will cause the blanking pulse to rise a number of units. A totally black picture will cause the blanking to rise 40 units. KQED rules out any picture information which will cause a shift above 25 units on the IRE scale.

Figure 9A illustrates an all-too-typical use of pool stage lighting for television. The deterioration of the artistic effect originally conceived by the producer is evident. Unfortunately, far too many network shows are still trying to use this pool lighting effect. The unclamped waveform display of this picture is shown in Fig. 9B. At a glance the engineer can observe the unbalanced nature of the video envelope. The blanking level has shifted to about 32 units, above the previously mentioned "no-go" limit of 25 units.

One possible solution to the pool lighting problem is to provide additional white information in the picture while trying not to destroy the esthetic effect desired. For example, in Fig. 10A the addition of light slashes and white pillars aids the waveform balance and allows the unrestored receiver to reproduce the blacks with much better fidelity than Fig. 9A. The waveform display (Fig. 10B) for this modified lighting now shows a shift of less than 20 units.

Figure 11A illustrates the "limbo" low-key, long shot which reproduces badly on the unrestored receiver because of the high proportion of black components. The waveform shift is shown in Fig. 11B to be about 28 units. Tightening up the shot, as shown in Fig. 12A, improves the gray-scale rendition. The waveform shift for this close-up shot is shown in Figure 12B to be 14 units. It is not intended to suggest that these shots are interchangeable in program or esthetic content. The point is that generally a long shot in black limbo is poor pictorial competition with a tighter shot containing a higher percentage of light grays.

Under unrestored conditions, gray-scale distortion also takes place with large areas of white as well as with large areas of black. Under large white area conditions, the low grays are clipped and become blacks. However, the distortion is not nearly so noticeable, since the blanking and sync pulse provide a constant black component to balance any white video component.

If the waveform monitor is consistently used to assess the staging, lighting and shooting, the picture in the home will much more closely resemble that in the control room. A great deal of ingenuity is required of the broadcast engineer to correlate the artistic requirements of the program and the technical requirements of an unrestored receiver.

A few months ago the author mailed a questionnaire to the engineering heads of all television stations and networks in the United States and Canada, asking for opinions on restored versus unrestored sets. More than 200 were returned and every one indicated the

Fig. 10A. Similar to Fig. 9A, except that white components have been added to improve gray-scale rendition on unrestored set.

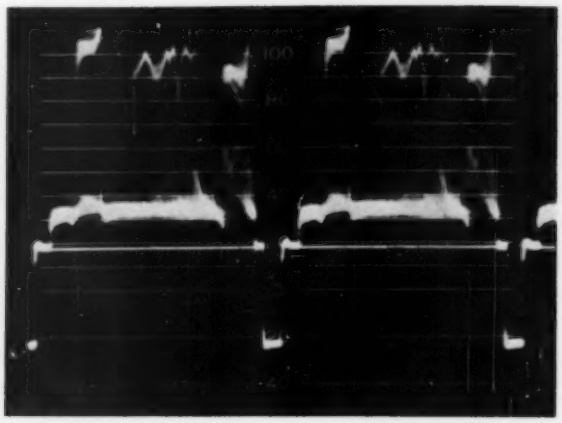


Fig. 10B. Waveform of picture in Fig. 10A. Blanking shift is now only 19 IRE units.

Fig. 11A. Unrestored, low-key "limbo" picture.

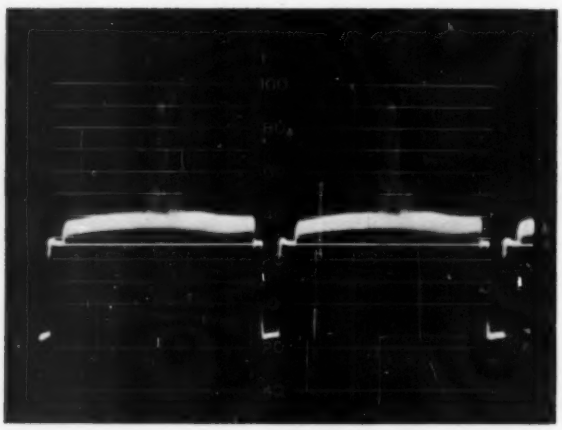


Fig. 11B. Waveform of picture in Fig. 11A. Blanking shift is 28 IRE units.

desirability of preserving the d-c component in the home receiver.

Conclusions

Elimination of the d-c component from the home receiver must necessarily mar the photographic quality of the picture.

Second, it appears likely that the manufacturer will eventually provide sets capable of reproducing the full d-c component signal sent out by the broadcast station. Concurrently there will be, we believe, an attempt to provide a higher quality of picture and sound in place of the present obsession with gadgets, gimmicks and glitter. Improvements in high-voltage regulation, transparent phosphors, adequate sound systems, etc., are long overdue.

These advances will, of course, not be without cost and will require strong motivation. That motivation might very well be found in currently slumping sales curves.

The third conclusion is that the broadcast engineer should, wherever possible, adjust his staging, lighting and shooting techniques to take into consideration the problems of the unrestored set.

The broadcaster has indicated overwhelmingly his preference for the d-c component in the home set. He knows that it imposes upon him the task of rigid level control and standardization. It is to be hoped that the manufacturer will see his way clear to give back to the viewing public a picture with true blacks and whites.

Acknowledgments

The author is indebted to the KQED engineering staff, and particularly to Studio Supervisor Bernard Stoffer, for excellent assistance in the preparation of the data and pictures. The drawings for Figs. 3–7, inclusive, are here used by courtesy of *Electronic Industries*, for January 1960.

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Discussion

Pete Pedersen (RKO General, Don Lee Broadcasting System): In approaching this problem has the mode of operation of home receivers been taken into account, particularly the ambient light condition which in general causes the average viewer to run a very high brightness level, simply so that he can see what is in the dark scenes that we broadcasters love so much to put on the air?

Mr. Nissen: Yes, this is definitely a consideration. In my opinion, one of the most important areas that should be studied by a receiver manufacturer is the use of transparent phosphors (or black phosphors, whichever seems preferable) for cutting down glare and reflection from the set, so that the ambient level of light in the room is not so detrimental to picture quality.

Mr. Pedersen: This is really part of the same question. My impression is that the usual reaction of viewers to receivers with d-c restorers is that the brightness must continually be adjusted. Did you find that some non-technical people who watched restored and non-restored receivers side by side preferred the un-restored receivers?

Mr. Nissen: No, I did not get that reaction. In the series of tests we conducted with laymen I was interested only in their reaction to a restored versus an unrestored set. At this point I did not want to confuse the results by considering the problems of a misadjusted set or high ambient light level.

Mr. Pedersen: You spoke of broadcast practice

Fig. 12A. Close-up shot of subject shows improved rendition of gray-scale.

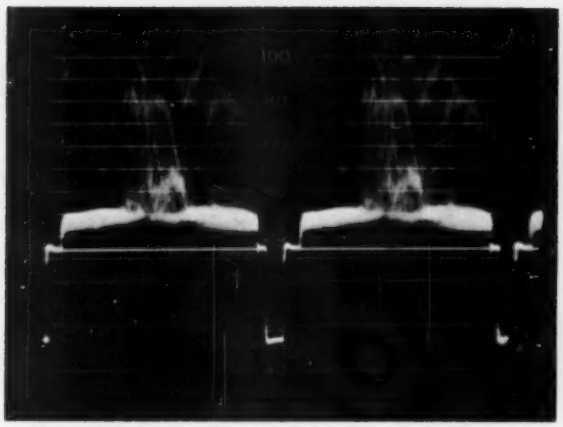

Fig. 12B. Waveform of picture in Fig. 12A. Blanking shift is only 14 IRE units.

and a point occurred to me that is very much in line with what you said about "putting a little white in the dark pictures" and "dark in the light pictures." If we compare the audio portion of the television program with the audio portion of, say, a theatrical motion-picture film, we would find that the low-level portions of the audio must be jacked up; and then, when we come to climaxes and crescendos, gunshots and so on, it must be pulled down or the limiter will be lighted continuously. The point is that the modern home has a high ambient noise level in a picture sense as well as an audio sense; therefore it is not feasible to have even the brightness contrast level that the TV system is capable of, limited though it is, compared with films shown in a theater. You touched on this but I think that this is a point that can bear further consideration.

Mr. Nissen: I agree with you on the audio system, that under certain conditions there must be more compression for television because of the noise level in the home. We might argue about the degree of compression, but the need for it is recognized. With regard to the picture and the contrast ratio involved, if we have either low ambient lighting conditions or some means by which the front ambient light on the picture does not destroy its low scale, then I would argue most strongly that you *can* put into the receiver the dynamic range that you have in the control room. This assumes, of course, adequate high voltage regulation and amplitude linearity in the receiver.

Mr. Pedersen: Would you hide the screwdriver control for d-c brightness?

Mr. Nissen: I would not. It has been suggested by several people in the set manufacturing industry, top-flight engineers, etc., that, if we can get the broadcasters to nail their levels down, then they see no reason why they could not incorporate circuitry to clamp solidly on black. It then might be possible to preadjust the reference whites to emit a certain amount of light from the tube and reference black to go to beam cutoff. But, first, it seems there are problems connected with ambient light conditions that must be solved.

Don McClosky (American Broadcasting Co.): In reference to the nontechnical tests you conducted: was switching between channels at varying signal strengths involved in any way?

Mr. Nissen: No. Two sets, placed side by side, were used in the tests. Varying picture information ran the full gamut from total black, through portions of properly balanced waveform material, to high white content; in other words it ran the entire range of waveform balance. The people viewing were simply asked, "Which is the better quality picture?" That was the only question. Of the 265 tested there was not one person who preferred the unrestored set.

Mr. McClosky: Was that off-the-air or live?

Mr. Nissen: It was not off-the-air but the frequency response was degenerated to that approximating a home receiver, that is somewhere around 3½ megacycles.

Mr. McClosky: Do you think that this might be an important consideration in some areas where signal strengths are not equal?

Mr. Nissen: Yes, I think it would. And this could be solved very simply by a switch on the back that says "Restored" - "Unrestored."

Mr. McClosky: In your opinion, does a keyed clamp have great advantages over a sync tip restorer?

Mr. Nissen: It certainly does because of its lower noise susceptibility — because, of course, it's operating 5 to 8% of the time, whereas a peak rectifier restorer operates 100% of the time. In addition, the keyed clamp has a superior ability to maintain rigid black level, and since the clamp reference can be the back porch, variations in sync level are irrelevant.

Edward P. Ancona, Jr. (National Broadcasting Co.): The discussion so far has been dealing with some of the finer, although certainly still valid, points of the electronic and viewing conditions that surround this matter. I would like to put on record, though, that some of the most serious problems in this area involve film photography for television. Unrestored picture and waveform monitors can be used in the broadcasting studio as a guide to the electronic technicians who are putting on a live television show. However, to motion-picture film photographers, the loss of d-c restoration is an alien electronic problem having no direct relation to any behavior of motion-picture films, and it is extremely difficult to explain to these people, whose specialties are outside the field of electronics, the nature of the behavior of an unrestored receiver. It is likewise difficult to give them some guide whereby they can predict how a picture they are photographing on film will later be reproduced on the home receiver.

These people, who are certainly conscious of picture quality, often watch their own product on home receivers, almost all of them unrestored. Bitter complaints are often voiced the day after certain of their commercials or films have been broadcast, such as, "What in the world did the broadcasting technician do to the film! Why was it so black — or, why was it all washed out! It certainly didn't look like that in the review room; furthermore, it didn't look like that down in the studio on closed circuit." I'm sure you all know the origin of these complaints: it is simply that these people do not understand that their expensive receivers with beautiful cabinets do not behave like the studio monitors. In my opinion, the most valuable use of the switch, now installed on some studio monitors to remove d-c restoration, is to educate television film photographers and producers in the behavior of the typical home receiver.

I might end by saying that the Motion Picture Research Council recently gave a rather elaborate and extensive demonstration of this phenomenon on a studio monitor and an unrestored home receiver placed side by side. A number of motion-picture scenes, varied in average transmission over a wide range, were compared on the two displays; and of course the unanimous opinion of the people who saw it, including a number of professional cinematographers, corroborated the data obtained from the 265 laymen tested by Mr. Nissen.

Rudy Rear (Jet Propulsion Laboratory, Pasadena): Digressing from the technical aspects, what sets are on the market today that do have d-c restorer circuits in them?

Mr. Nissen: When I presented the questionnaire to the manufacturers I stated that it would be used in preparing a paper, so it seems that the replies can be made public. The questionnaire went out about a year and a half ago. As far as I know the only non-custom-built monochrome set with d-c restoration is the Fleetwood, which is built by Conrac. There may be some very small companies not included because they were statistically unimportant to the overall picture in the United States.

Ken Winslow (Dept. of Visual Communications, University of California): So far, most of your material has covered the conditions of studio and home viewing. In the area of closed-circuit operations in colleges and universities, or in situations where there is no control over staging and lighting, such as remotes, the use of the unrestored receiver is a very great problem. Such considerations should get more attention from receiver manufacturers. An example of a problem situation in this area is the viewer who is looking at a blackboard with perhaps only two or three squiggles of chalk on it. There are added problems arising from the use of vidicon equipment which under many conditions of closed-circuit use, has a restricted gray-scale rendition.

Application of 35mm Sprocket-Hole Film to Instrumentation Recording

By J. W. STAFFORD
and G. R. CRANE

Perforated-type film has certain inherent advantages as a recording medium. Performance characteristics of flutter, drift, skew and general operational stability of a typical transport system using 35mm perforated film are given. Standard 5-mil cellulose acetate, as well as 3-mil and 1½-mil Mylar base films, is included at speeds of 9–126 ips (inches per second). Analysis of performance serves to indicate advantages to be gained in applying sprocket-hole film to instrumentation recording.

With the growing complexity of instrumentation, data processing and automatic control, there is a continuous demand for improved methods of information storage. At present a large proportion of these data is recorded on magnetic tape. The amount stored per unit area of the medium can be used as a figure of merit and an increase of this value is continually being sought. One limiting factor is nonuniform motion of the recording medium as it passes through the equipment. Various aspects of this limitation, particularly with respect to 35mm perforated film, will be presented.

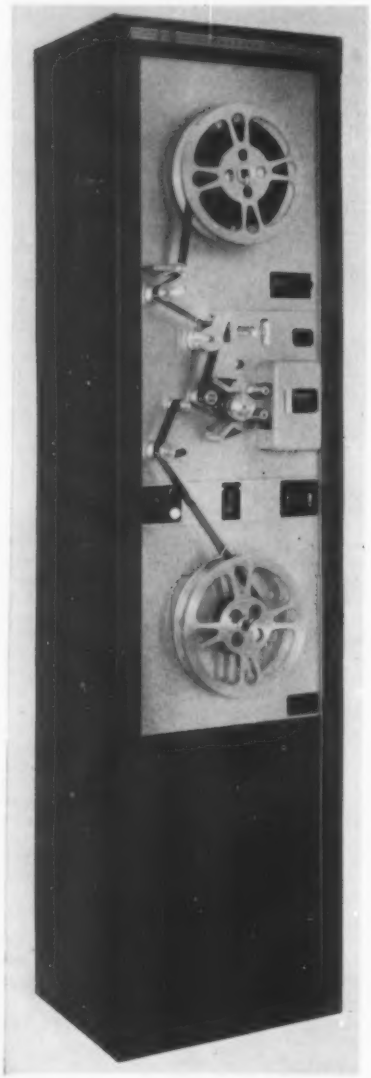

Fig. 1. Westrex RA-1552-F 35mm Magnetic Film Recorder.

As is well known, the accuracy of perforating film as used in the motion-picture industry has been perfected to such an extent that average samples are usually considerably more accurate than called for by ASA specifications. The position of the film in special-effects and multiple-exposure photography is being held to within 0.0001–0.0002-in. tolerance from frame to frame with less than 0.1% accumulated error throughout a complete reel of film. Advantage can be taken of this perforating accuracy to meter repeatedly a given length of film through a system to within perforation limits. Furthermore, a given recording can be reproduced on various machines without the need of recording a timing track. In applications where definite metering and indexing of the recording medium for long periods of time are essential, sprocket-driven perforated film offers a simple solution.

Performance Measurements

Following preliminary studies of the stability, flutter and drift characteristics of 35mm magnetic film equipment, considerable time and thought were devoted to methods of quantitative evaluation by means of available laboratory equipment, including a General Radio Type 1217-A Unit Pulser, a Hewlett-Packard Model 100B Low Frequency Standard, two Tektronix Type 532 Oscilloscopes and Ballantine Decade Amplifiers.

A Westrex RA-1552-F 35mm Magnetic Film Recorder (Fig. 1), provided with a Clevite 14 staggered-track ¼-mil gap head was used as a typical transport system. The basic film drive has been described previously in the *Journal*.[1,2] The filtered section of the film path is of primary importance here. Briefly, it includes a single 40-tooth film sprocket, two rollers which provide damped compliance, and two film-driven impedance drums. This arrangement provides high attenuation of disturbances originating in the feed or take-up sections, motor system or driving mechanism components. In addition, two damped shock rollers are used to absorb any shocks which might be introduced by feed and take-up reels and the effects of the high inertia of large film reels. Such a system provides a uniform film motion over the magnetic heads with a total flutter content of less than 0.1%.

Performance characteristics studied were primarily flutter, drift, skew and general operational stability. Three base types of film were used, namely, regular 5-mil cellulose acetate, 3-mil Mylar and 1½-mil Mylar. The 5-mil cellulose acetate and the 3-mil Mylar behaved so nearly the same that there were no observable differences and therefore tabulated characteristics given will not include the heavier base. In order to cover a rather wide range, tests at speeds of 9, 18, 58 and 126 ips were made. This speed range covers reasonably well current practice in instrumentation and data processing.

Two types of flutter measurement were made. One was to measure total flutter, zero to peak, in the frequency range of 1–200 cps on the Westrex Flutter Bridge. The other was to measure time displacement error (TDE) by observing the position by recorded and reproduced electrical pulses on cathode-ray oscilloscopes.

In order to evaluate TDE due to flutter and drift throughout a reel of film, pulses were recorded simultaneously on two tracks, one track to serve as a time reference, the other to derive measurements of time variation during reproduction of the accurately timed recorded pulses. Adjacent tracks in the center of the film were used so that skew error would be negligible.

Two Tektronix oscilloscopes were used in both recording and reproducing the pulses from which TDE was determined. For the benefit of those interested, specific details and procedures are given in Appendix I.

Several methods were used to measure skew. The following appeared to give the most satisfactory results and was the method used in obtaining the data which are presented later.

Presented on May 3, 1960, at the Society's Convention at Los Angeles by J. W. Stafford (who read the paper) and G. R. Crane, Westrex Corp., 6601 Romaine St., Hollywood 38.
(This paper was received on April 14, 1960.)

The General Radio Unit Pulser was used to generate a 50-μsec pulse at a repetition frequency of 2 kc. This pulse was used both to record a reference track and to trigger the Tektronix Oscilloscope which, in turn, was used to generate approximately a 30-μsec pulse delayed 20 μsec with respect to the rise of the pulse from the unit pulser. This delay was accomplished by taking advantage of the delay gate feature of the oscilloscope. The delayed pulses were recorded on various tracks to be used for skew measurements. The relative positions on the film of the rise of the 50- and the 30-μsec pulses determine the overall amount of skew of both recording and reproducing.

To measure skew, the tracks described above were reproduced on the RA-1552-F recorder. The rise of the 50-μsec pulse of the reference track was used to trigger the oscilloscope, and the position of the rise of the delayed pulse was observed at a sweep speed of 4 μsec/cm. Total position change or jitter was estimated to 0.1 cm, so that skew TDE values to 0.4 μsec were obtained.

Since the amount of TDE should be proportional to the distance between the reference track and the measured track, TDE was plotted against the distance between centerlines of the tracks. The results are shown in Fig. 2. The curve should be a straight line through the origin. The correlation of plotted data to desired value is quite good, the maximum discrepancy being about $\frac{1}{4}$ μsec.

The skew measurements above, in terms of TDE, give the total peak-to-peak errors. In order to see the distribution of error throughout a 1000-ft roll of film, the method of measurement was revised so that discrete pulses at uniform intervals could be measured. To accomplish this sampling of pulses, two Tektronix oscilloscopes were used, as described in Appendix II.

If skew variations are strictly random, then data derived in the manner described above, when plotted with TDE as abscissas against occurrence frequency as ordinates, should give a normal Gaussian error distribution curve. To verify whether the Gaussian distribution of error held in this case, test data were plotted on probability paper.

The normal procedure of plotting group number (in this case arbitrary oscilloscope graticule readings) against the accumulative per cent in the group, indicated a straight line would fit the data best. From this straight line the standard deviation of sigma was determined. This probability functional relationship is shown in Fig. 3, with group number as abscissas and accumulated per cent as ordinates. Since errors are plus or minus, the 50% point was taken as zero error and the abscissa corresponding to this value was determined on the group number scale. Sigma was determined by finding the abscissa corresponding to 84.13 (zero error at 50% plus standard deviation of 34.13) on the accumulative per cent scale. (See Appendix III for a more detailed description of probability procedures.)

It should be pointed out that, in order to see on the oscilloscope the plus or minus variations in the instantaneous position of the pulses being measured, they had to be delayed with respect to the reference triggering pulses. The amount of delay was 20 μsec, so that actually measurements of instantaneous position included variations due to both skew and flutter. However, since total flutter is known to be of the order of 0.1%, its contribution to the total TDE will be no greater than 0.001 times 20 or 0.02 μsec which, in this case, is negligible.

Having established procedures, tests were made on the different film bases at the various speeds.

A direct comparison of the performance of $1\frac{1}{2}$-mil and 3-mil base film was made. The study included measurements of skew and flutter at speeds of 9, 18, 58 and 126 ips. At 58 ips, error distribution as well as total errors were measured. Since, in general, instrumentation and data processing systems require having a maximum available recording medium in a given space, 5-mil base film was not included. However, preliminary tests indicated no appreciable difference in the performance of 5-mil base and 3-mil base film.

It might be of interest to note that a sample of $1\frac{1}{2}$-mil cellulose acetate base film was checked during these tests but was discarded as being unsatisfactory because of its low strength. It proved very difficult to accelerate reels and machine without tearing the film or pulling out sprocket holes. Such a film certainly could not give reliable routine trouble-free use.

The $1\frac{1}{2}$-mil Mylar base film gave little trouble in starting and operating at 58 ips. The tensions on the feed and take-up reels were reduced somewhat, however, in order to reduce the load on the sprocket holes while the machine was

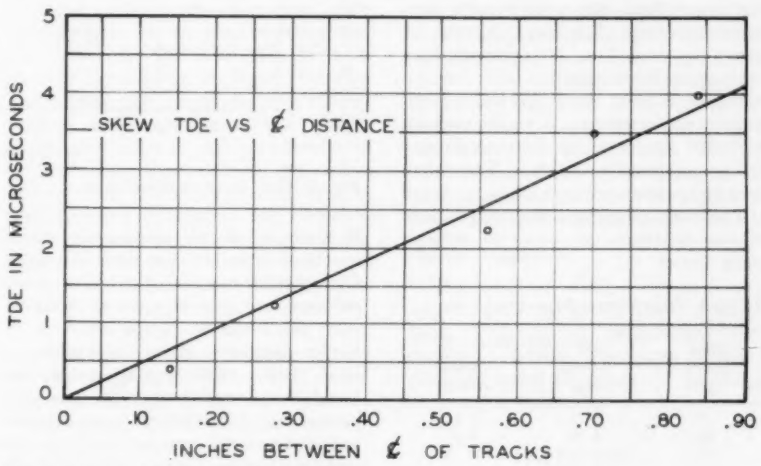

Fig. 2. Skew TDE vs. centerline distance.

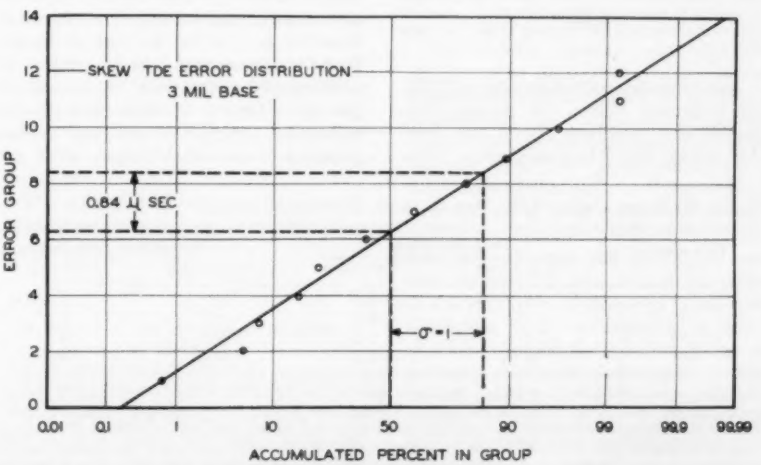

Fig. 3. Skew TDE vs. error distribution, 3-mil base.

accelerating. For the same reason, one extra sprocket hole was added to the length of loop over the impedance drums. Aside from these two slight changes, the machine was operated with the normal adjustments used with standard 5-mil base, cellulose acetate film. The 2400-ft roll was run without difficulty a couple of times before making actual measurements. Operation appeared completely satisfactory.

Data Analysis

Comparative flutter tests consisted of total TDE vs. time at 58 ips only. At other film speeds, total flutter was simply measured on the Westrex Flutter Bridge. The curves of Figs. 4 and 5 show the results for 1½-mil and 3-mil Mylar base film, respectively. Data for the 3-mil film were taken from previous tests and do not conform too closely with the 1½-mil case. The 3:1 increase in per cent total flutter is without doubt a question of machine drift characteristics rather than a change due to difference in film base. Had the wide variations been noticed while data were being taken, the 3-mil base film tests would have been repeated. However, it can be seen that, aside from the relatively long time drift, the amount of TDE for the two cases is quite nearly the same. Total flutter measurements, i.e., frequencies of 1–200 cps, from the Westrex Flutter Bridge are given in Table I. The values are for peak-to-peak change, or twice the readings taken from the bridge, since it was calibrated in terms of zero-to-peak flutter.

Table I. Total Flutter Measurements.

Film speed, ips	Peak-to-peak flutter, %	
	1½-mil base	3-mil base
9	0.10	0.11
18	0.08	0.07
58	0.12*	0.10
126	0.12*	0.10

* In view of other measurements, these values appear to be somewhat high, indicating variation due to the machine rather than to the thin base film.

Skew was determined in terms of TDE, as described above, at various film speeds, and with both 1½-mil and 3-mil Mylar base film. The data given in Table II were obtained during a period of several months, so that there are slight discrepancies in some of the direct comparisons, owing to equipment variation.

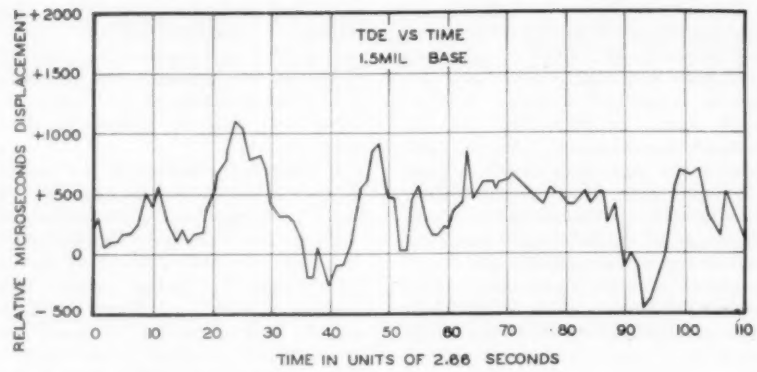

Fig. 4. TDE vs. time, 1½-mil base.

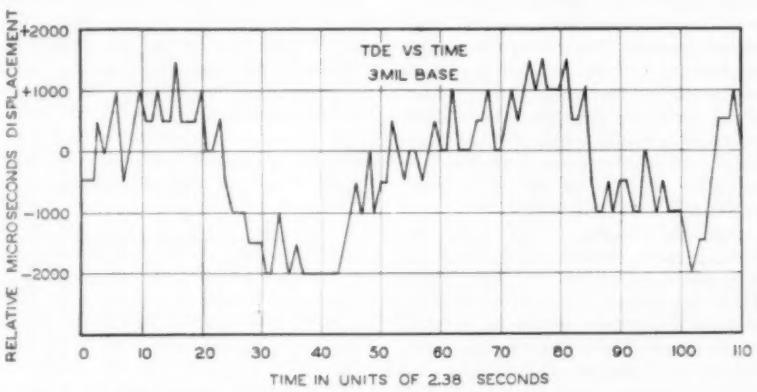

Fig. 5. TDE vs. time, 3-mil base.

At the speed of 58 ips, error distribution data were taken, in addition to total TDE. TDE was separated into error groups, and group numbers were plotted on probability paper against accumulated per cent errors. Since the resulting plots were approximately straight lines, indications were that error distribution was Gaussian, and standard deviations (sigma values) were computed from the graphs. In the case of 1½-mil base film, two sets of data were taken, at oscilloscope sensitivities of 2 and 4 μsec/cm. Figure 6 shows the plotted data. An average of the two curves yields a standard deviation, $\sigma = 1$, of 1.66 μsec, while in the case of the 3-mil base, the value was 1.68 μsec. If these values are rounded off to two figures, in both cases skew errors will be less than 1.7 μsec 68% of the time, less than 3.4 μsec 95% of the time and less than 5.1 μsec 99.7% of the time.

Table II. Approximate TDE Due to Skew, in Microseconds.

Film speed, ips	Adjacent tracks		Track separated 0.840 in.	
	1½-mil base	3-mil base	1½-mil base	3-mil base
9	2*	0.9	10*	8
18	1*	0.8	6*	6
58	0.6	0.5	4.5	4
126	(0.5)	0.5	(4.0)	4

* In the case of the 1½-mil base film at the slower speeds, skew appeared to have a high rate of change superimposed on a slower rate of about 2 sec. Values given include the change due to the sum of the two rates. The amplitude of the low rate was about twice that of the high rate. A recheck of the 3-mil base film showed this same effect, but to a much lesser degree, with only a few momentary sweeps appearing to form the slow rate. Values in parentheses were more of an estimate than a good reading and are therefore not regarded as reliable.

General Operational Stability

Machine performance was essentially the same with all three base thicknesses. The 5-mil cellulose acetate and the 3-mil Mylar behaved so nearly the same that there were no observable differences. With the 1½-mil Mylar base, machine alignment was somewhat more critical, and film tensions throughout the machine required slight readjustments. After attaining equilibrium speed, performance seemed to be independent of thickness of film base.

Stability at the various speeds was excellent. No mechanical difficulties were encountered although, in general, time to reach stability increased progressively with speed, primarily because the machine was operating at speeds above its normal design value. If required, design could be changed to accommodate the higher speeds. As might be expected, at the lower speed more drift and flutter were present and operation tended to be less stable.

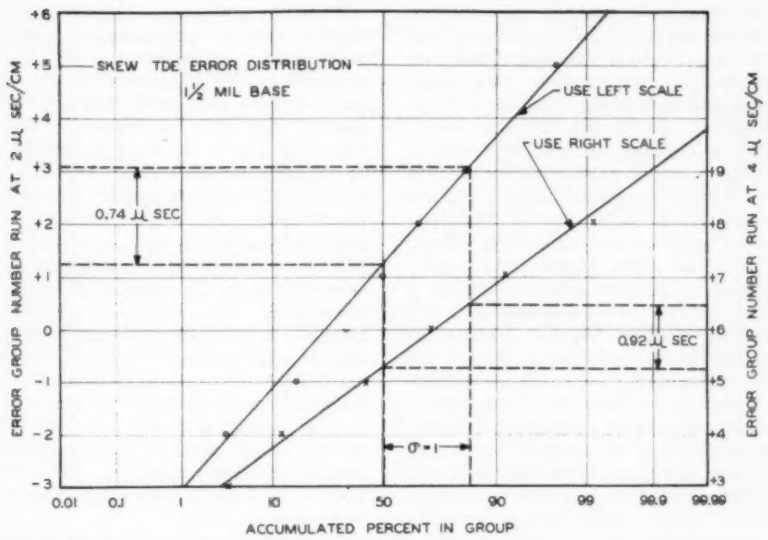

Fig. 6. Skew TDE vs. error distribution, 1½-mil base.

Typical Instrumentation Application

As a typical example of the application of 35mm perforated film for instrumentation use, a film-transport system was required that would move film continuously past the recording point at a uniform speed of approximately 18 ips with a flutter value, as determined by ASA Z57.1–1954, not to exceed 0.05%. Another requirement was that for any 1-sec interval of time, the specified length of film passing the recording point should be equal to the length in the following 1-sec interval to within a tolerance ΔL, where ΔL would have a frequency distribution standard deviation of $3\sigma = 0.004$ in.

The film motion in an RA-1552-type transport, described earlier in the paper, is known to be uniform to within the above limits except for slow drift, largely due to line frequency variation. The transport system was therefore designed with this type of film drive. However, driving power was derived from a tuning-fork stabilized oscillator rather than from the use of line frequency. By this procedure slow drift variations were substantially eliminated.

To evaluate system performance, probability methods were employed to determine whether the specification limits of $3\sigma = 4$ mils were met. In order to derive the value of σ for a given set of conditions — in this case a change in length for a specified length — a large number of measurements of deviations are necessary to establish valid averages. Actual deviations are then separated into ranges and the number falling in given ranges tabulated so that a curve of deviation vs. per cent occurrence can be plotted. If the errors are purely random, the curve will be the normal Gaussian distribution from which error probability and standard deviation σ can be derived.

To determine ΔL for the given transport system, a 1000-cps square wave was recorded at the normal film speed of 96 sprocket holes/sec, giving a wavelength of approximately 19 mils. To measure visually the ΔL due to flutter, the film was passed over dual scanning optical systems with scanning points spaced 96 sprocket holes or the equivalent of 1 sec apart. Special precautions were taken to keep film conditions, especially tension, constant throughout the measurements to ensure equivalent lengths being measured. The images thus formed were projected on a screen at a magnification of 100:1. By using the position of the rise of the 1000 cps square waves as index marks, it was possible to measure ΔL/sec quite precisely. By means of a scale on the projection screen, direct measurements of deviations were made within an accuracy equivalent to 0.25 mil on the film. An integration interval or cell width of 0.5 mil was chosen, therefore, so that plotted deviation values would be well within the limits of measurement accuracy.

A total of 480 measurements of ΔL were taken. The number falling in the specified integration intervals or cell widths compared to the number required for a 3σ limit of 0.004 in. is shown in Table III.

The standard deviation σ for the 480 ΔL measurements was computed by means of the formula

$$\sigma = [(\Sigma x^2/n) - \bar{x}^2]^{1/2}$$

where

x^2 = sum of the squares of n values of measurement of ΔL,
$\bar{x}$ = mean value of ΔL, and
n = number of measurements = 480.

The value of σ turned out to be 0.795 mil so that $3\sigma = 2.385$ mils. This was considerably less than the requirement of 4 mils.

Figure 7 shows the data plotted as a normal probability curve with ΔL in mils plotted as abscissas against Fc, a computed value of the probability function, as ordinates. The full curve shows results from the empirical data, while the dotted curve is the theoretical one for $3\sigma = 0.004$ in.

Conclusions

Analysis of the performance of 35mm sprocket-hole film indicates special advantages to be gained in its application to instrumentation recording.

Values of flutter, drift, skew and machine operating stability compare favorably with the best that are being obtained currently on tape equipment. Furthermore, the use of the perforated medium makes it possible, as well as practical, to position the film accurately along its length without elaborate feedback servo-control and timing tracks. In cases where integrated time error over long periods must be kept small, the perforated medium should prove especially efficient and simple.

Tests indicate that the use of 35mm 1½-mil Mylar base perforated film would be both feasible and particularly satisfactory in many instrumentation applications; 6400 ft of such film could be handled on a standard 15-in. reel. At the 60-ips rate, running time would be about 21 min. Indications are that film life would be excellent, and that after repeated use, performance characteristics would remain completely satisfactory.

Acknowledgments

The authors wish to express their appreciation to R. V. Roelofs for his help in developing oscilloscopic techniques; and to the Minnesota Mining & Manufacturing Company for furnishing film used in this study.

APPENDIX I

Oscilloscopic Techniques for Measurements of TDE Due to Nonuniform Film Motion

The normal positive gate and the delayed gate from a Tektronix oscilloscope were used as signals for recording a reference and measurement tracks, respectively. A repetition frequency of 10 cps was used. The delay was set to a maximum so that the rise of the normal gate was ahead of the rise of the delayed gate by approximately 96% of the repetition cycle. Flutter and drift TDE was then measured by sampling single cycles of the repeating sequence of events and measuring their wavelengths in terms of time required for the film to travel from the rise of the normal gate to that of the delayed gate. The method obviously includes errors introduced in both recording and reproducing.

In order to measure total flutter and drift, two Tektronix oscilloscopes were

used in the following manner. The reference track was used to trigger oscilloscope 1 at a repetition rate of about one second. The delayed gate from 1 triggered oscilloscope 2 which was set at a sweep speed of 100 μsec/cm. By adjusting the amount of delay, the rise of the pulse from the measurement track could be centered on oscilloscope 2 so that change in position could be read directly from the graticule. Readings were estimated to 0.1 cm. By this procedure, TDE due to nonuniformity of motion of the film could be determined, in terms of time variation, to within approximately 10 μsec.

A second method using an extremely long time base for the accumulation of flutter was also employed. In this case both oscilloscopes were used in recording. A 10-kc frequency from the Hewlett-Packard frequency standard was connected to both the A channel input and trigger input of oscilloscope 1 which, in turn, was set at a sweep rate of 100 msec/cm. The positive gate out of oscilloscope 1 was used to trigger oscilloscope 2, which was set at a repetition time greater than one cycle but less than two cycles of oscilloscope 1 repetition. In this manner oscilloscope 2 would sweep once for each two sweeps of 1. The positive gate from 2 was recorded as the reference track. Oscilloscope 1 was set for alternate sweeps of channels A and B. Since the 10-kc was connected to A channel, and no signal to B channel, the cathode follower out of oscilloscope 1 consisted of equal alternate sections of 10-kc and no signal. This alternation was recorded as the measurements track. Since oscilloscope 2 swept on alternate sweeps of 1, it was desirable to have it triggered at the beginning of the no-signal sweep of 1. This was accomplished by simply turning 2 on and off, observing which sweep triggered 2, and, when correct, simply leaving the switch on.

To measure the position change due to drift and flutter, the rise of the gate of the reference track was used to trigger oscilloscope 1. In turn, the delay gate out of 1 was used to initiate the sweep of 2 at a sweep speed of 500 μsec/cm. The first cycle of the 10-kc was adjusted to fall approximately in the center of 2 by changing the delay gate out of 1. In this manner the instantaneous positions of specified 10-kc cycles could be measured on the graticule of oscilloscope 2.

APPENDIX II

Oscilloscopic Technique for Measurements of TDE Distribution Due to Skew

In order to sample throughout a reel of film TDE due to skew, 50 μsec pulses were recorded on the two outside tracks, 840 mils apart. Pulses were recorded directly for a reference track. These same pulses were delayed about 20 μsec before recording for the measurement track. The delay is necessary so that on reproduction the rise of the delayed pulse can be seen on the oscilloscope. During reproduction the reference track pulse triggered oscilloscope 1 which, in turn, triggered oscilloscope 2. The sweep rate of 1 was set to 2 sec and that of oscilloscope 2 to 4 μsec/cm. The delayed pulse from the measurement track was observed on oscilloscope 2. The sampling sequence was therefore as follows. A reference pulse triggers oscilloscope 1 which, in turn, triggers oscilloscope 2 and one delayed pulse is seen on 2 at a fast sweep speed. Number 2 now waits for its next trigger from 1. During this waiting period 1 continues on through its 2-sec sweep, and, when completed, is again triggered by a pulse from the reference track and the sequence is repeated. By this procedure, instantaneous skew is measured by the position of discrete pulse images on the fast-sweep oscilloscope tube face. Values were determined to 0.4 μsec.

APPENDIX III

Probability Methods

In the analysis and correlation of measured data, such values as error of measurements, averages, deviations, probable error and Gaussian error distribution are useful in describing the characteristics of systems in terms of empirical data. These terms are involved in the theory of probability and have been covered completely in the literature. Some of these relationships of probability theory will be reviewed briefly.

One form of the general equation of the normal probability curve is

$$y = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[\frac{-(x-\bar{x})^2}{2\sigma^2}\right]$$

where $\bar{x}$ is the mean value of the variable x, and the constant σ is commonly referred to as the standard deviation and is effectively a measurement of dispersion of a given number of observations. The curve is sometimes called the "error" curve or Gaussian law of error.

If the origin of this curve is taken at the mean, $\bar{x}$, the equation reduces to

$$y = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[\frac{-x^2}{2\sigma^2}\right]$$

The standard deviation can be calculated from

$$\sigma = [(\Sigma x^2/n) - \bar{x}^2]^{1/2}$$

where

x^2 = sum of the squares of n values of measurements,
x = mean value of measurements, and
n = number of measurements.

The probability of an error occurring between the limits x_1 and x_2 is given by

$$\text{probability } Fc = \frac{1}{\sigma\sqrt{2\pi}} \int_{x_1}^{x_2} \exp\left[\frac{-x^2}{2\sigma^2}\right] dx$$

Thus, the definition of a probability curve is that the area under the curve between any two points represents the probability of the given event occurring between these two limits. The mathematical integration indicated in the expression can be achieved graphically by dividing the area under the curve into a series of rectangles of predetermined width and height. If each of these rectangles has the same width, and if the sum of the heights equals unity, then the sum of the areas of rectangles between any two limits will give an approximation of the integration, and thus the procedure for the graphical solution of probability function is established. Obviously, as the number of rectangles or cells is increased and the width is correspondingly decreased, the approximation will approach the true value, so that in the limit mathematical integration will be obtained.

The procedure in preparing the empirical data for this graphical solution follows. The measurements are tabulated and the differences from the mean are computed. The differences are examined to determine a reasonable group or cell width for the integration process. The choice is quite arbitrary. If the width is made too small, there will be too many cells with no measurements, and if the width is made too large, integration will be poor. The number of measurements within each cell are counted and arranged progressively in order from those in the cell with largest deviation below the mean to those in the cell with largest deviation above the mean. Since the total area under the curve must equal unity, if the per cent or fractional number of the total number of measurements is computed for each cell and plotted against its corresponding cell position, the sum of the areas of all the cells will be unity in terms of total deviation. In plotting the curve, the center of each cell is taken as the position of the abscissas and the percentage or fractional number of measurements are plotted as ordinates. The resulting curve is the approximation of the probability, and if errors are completely random, the distribution of errors will follow the Gaussian law of error. The curve will be symmetrical about the maximum, which in turn defines the mean value of the measurements. The standard deviation σ can be derived from this curve by estimating areas or measuring them with a planimeter, and finding that area—bounded by the X-axis, the ordinate at the maximum, the curve and a second estimated ordinate—which is 34.13% of the total area bounded by the complete curve and the X-axis. The 34.13 value is taken from normal error curve tables and is that value for which σ equals unity.

A second, and possible preferable, graphical method is to plot the data on

Table III. Measurement of Tolerance ΔL.

ΔL, mils	No. in group measured	Per cent of total	No. required for $3\sigma = 4$	Per cent of total, $3\sigma = 4$
−4.0	0	0	1	0.16
−3.5	0	0	2	0.48
−3.0	0	0	6	1.19
−2.5	0	0	12	2.55
−2.0	8	1.66	23	4.86
−1.5	18	3.75	38	7.91
−1.0	52	10.83	54	11.30
−0.5	86	17.91	68	14.02
0.0	142	29.58	72	14.98
+0.5	90	18.75	68	14.02
+1.0	58	12.08	54	11.30
+1.5	17	3.54	38	7.91
+2.0	8	1.66	23	4.86
+2.5	1	0.20	12	2.55
+3.0	0	0	6	1.19
+3.5	0	0	2	0.48
+4.0	0	0	1	0.16
Totals	480	99.96	480	99.92

"probability paper" or coordinate paper which has uniform spacings in one direction and, in the perpendicular direction, spacings that are proportional to the probability curve and are marked with the corresponding per cent values. The spacings are, of course, symmetrical about the 50% ordinate, and at any point the scale value is the per cent of the area under the curve from minus infinity to the point in question. It is apparent that a straight line on this type of coordinate paper will represent the Gaussian error law.

To plot the empirical data on probability paper, about the same procedure for tabulating measurements is used as in the case of normal coordinate paper. Deviation groups of cells are formed and the per cent of the number of measurements in each cell is determined and arranged progressively from maximum deviation below the mean to maximum deviation above the mean. Accumulated per cent is then determined by adding to the per cent in each cell the sum of percentages of all the cells ahead when progressing as above. The data are now in a form which can be plotted directly on the probability paper as deviation against accumulated per cent occurrence.

If a straight line fits the plotted data best, a Gaussian error distribution is indicated and errors can be considered as random. Since the curve is symmetrical about the maximum, the mean deviation is given by the abscissa corresponding to the point where the line crosses the 50% ordinate. Also, standard deviation can be obtained by finding the abscissa corresponding to the point where the straight line crossed the 84.13% ordinate. The 84.13 value is used since, by definition, a standard deviation of one is equivalent to 34.13% from the mean and the mean is at the 50% ordinate; therefore the 34.13 is added to the 50 to get 84.13.

It is obvious that if the sigma deviation is given, the corresponding Gaussian law curve can be derived by drawing a straight line through the points on the 50% and the 84.13% ordinates that correspond to the given values.

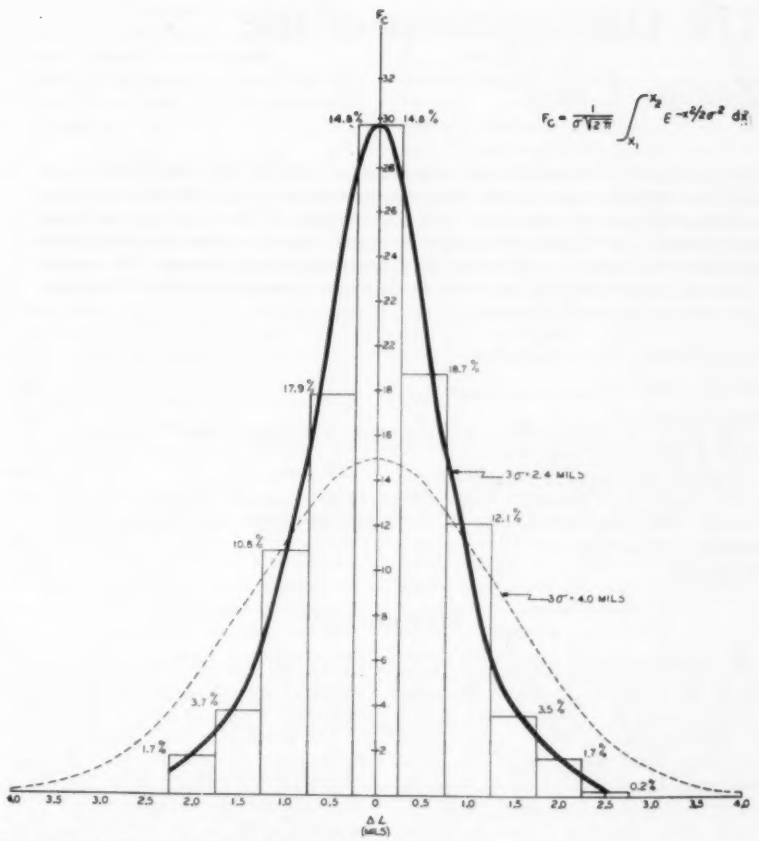

Fig. 7. Probable error, Fc, vs. flutter deviation.

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The Development of the Zoom Lens

By RUDOLF KINGSLAKE

Zoom, or varifocal, lenses have been known since 1930, but they were seldom used until after the second world war, when they became generally applied to television cameras. The past ten years have seen the development of several types of zoom lens for 8mm and 16mm motion-picture cameras. These are either mechanically or optically compensated, and necessarily contain many lens elements. The optical design is difficult, and it is only recently that zoom lenses comparable to ordinary cine lenses have become available.

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INTRODUCTION

A "zoom" or, more precisely, a "varifocal" lens,* is one in which the focal length can be continuously varied by moving one or more of the lens elements along the axis of the lens, the image being maintained in focus by either mechanical or optical means. A zoom lens naturally finds its widest application on motion-picture or television cameras, although some zoom lenses have recently been introduced for use on ordinary 35mm miniature cameras and on various film and slide projectors. The extensive subject of auto-focus enlargers is excluded from the present discussion.

The design of a zoom lens is particularly difficult because even a slight change in the position of an element in any ordinary photographic objective has a drastic effect on the aberration corrections. In designing a zoom lens, it is necessary for the designer to discover some way to compensate these aberration changes during a zoom, or at least to render the changes so small as to be insignificant. For this reason, existing zoom lenses at any one setting are generally not as good as a normal objective having the same focal length and aperture. In the past, designers have relied on the novelty of a varying image size to draw the observer's attention away from the inevitable small variations in image quality, but this is not a valid procedure, and, as a result of increasing complexity, some recent zoom lenses are actually as good as an equivalent fixed lens of normal construction.

Even when a zoom lens is available, motion-picture producers often prefer to use a moving camera, or "dolly-shot," because of the problem of perspective. Suppose we are photographing a person standing in front of a distant background object such as a mountain. Moving the camera forward will increase the size of the person on the film without significantly altering the apparent size of the mountain. However, increasing the focal length of a zoom lens will make both the person and the mountain increase in size together in the same proportion, which is generally considered undesirable. If all the objects in a scene are substantially at the same distance from the camera, a zoom shot and a dolly shot will be practically indistinguishable, and in that case the zoom lens is generally preferable because of its simplicity of operation. Zoom lenses are used extensively on television cameras, for both indoor and outdoor events, because of their convenience and versatility.

Whatever means are adopted for varying the focal length of a lens, the mechanism will produce a stationary image for only one object distance, generally infinity. When a near object is to be photographed, therefore, it is necessary to collimate the light from the object before it enters the lens. This may be done by adding a weak collimator lens in front of the system, of focal length equal to the distance of the object (Fig. 1). An alternative procedure is to move the front positive element of the zoom lens forward to focus the object, in the manner frequently employed to focus a low-priced camera. As this adjustment is difficult in some zoom systems, a "focusing collimator" consisting of a closely spaced pair of positive and negative lenses of equal power may be used. The focal length of this collimator can be shortened by merely increasing the separation between the lenses.

There is some question, too, as to what is the most desirable form of the law connecting the motion of the crank or lever which controls the zoom, with the resulting focal length of the lens. It was at one time[11] thought that a linear connection between the rotation of the crank and the focal length was desired, but it is now

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(This paper was received on June 10, 1960.)

* Also called in Germany a "rubber lens."

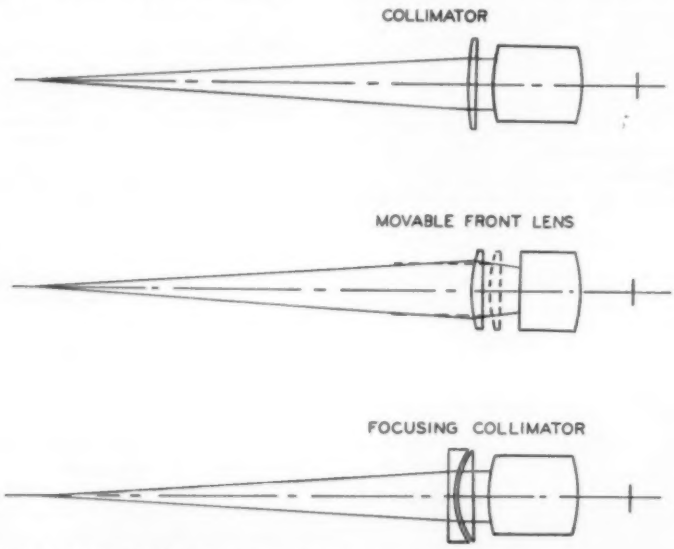


Fig. 1. Means for focusing a zoom lens on a near object.

felt that the connection should be logarithmic,[25] i.e. a given angular rotation of the crank, in any part of the scale, should change the focal length by approximately the same fraction of its starting value.

It should be remarked that theoretically some loss in definition must occur during a zoom (except in the center of the frame) because every point in the field will be moving radially outwards or inwards by a slight amount during the time of exposure.

In most zoom-lens designs, the iris is placed behind the last moving element so that the ultimate *f*-number of the system will remain constant while the focal length is changed. This, of course, inevitably leads to a large front opening. The alternative is to let the iris move with one of the moving elements, but then a cam must be provided to control the diaphragm in such a way as to maintain a constant *f*-number. This has actually been done in one or two instances.

Another essential requirement of a zoom lens is a satisfactory viewfinder. Many of the early zoom lenses were equipped with a coupled zoom viewfinder giving a view similar to the one being photographed, either with or without parallax correction. This method is fairly satisfactory, but it cannot be used to photograph through another optical system such as a close-up lens, a telescope or a microscope. A fixed viewfinder may be used, with a variable mask coupled to and working with the zoom lens, but since the mask must get smaller when the focal length is getting longer, the observer is liable to have the feeling that the picture is shrinking when actually it is getting larger on the film. The best procedure is to insert a beam-splitter behind the lens, by means of which a part of the image-forming light is reflected to the eye.

In Fig. 2 are shown two typical arrangements for a through-the-lens reflex viewfinder. In the upper system, the beam of parallel light emerging from an afocal zoom attachment enters a beam-splitting cube, the interface of which may be either partially reflecting all over, or it may carry only a small highly reflecting central disc (SOM-Berthiot). This small disc now constitutes the entrance pupil of an erecting telescope, and an image of the disc falls into the pupil of the observer's eye. The brightness of the viewfinder image is thus independent of the stop aperture of the camera lens. In the lower system of Fig. 2, the beam-splitter, which must now have a uniformly reflective interface, is mounted behind the entire zoom lens and forms a real image of the photographed object close to the prism. A field lens is placed at or near the plane of this image, which is relayed to the eye by a kind of low-power microscope. The visual image in this system loses brightness when the lens is stopped down. In either case, a pair of focusing wedges may be inserted into the beam in the plane of a real image, to facilitate focusing the zoom lens accurately.

Some general problems involved in the design of zoom lenses have been discussed in various articles.[18,23–25]

HISTORICAL SURVEY

Prior to about 1930, there were no real zoom lenses of any kind. The closest approach to a varifocal system was the well-known variable telephoto lens popular in the 1890's, which consisted of a normal photographic objective backed up by an achromatic "tele-negative" component.[1] The separation between the two components could be adjusted by a rack-and-pinion mechanism to vary the focal length of the combination. Since a change in focal length was inevitably accompanied by a change in image distance, it was necessary to vary the bellows extension to keep the image in focus. (Actually, the bellows length was usually established first, and the rack-and-pinion motion was then adjusted to focus the image sharply on the ground glass.) In the course of time, various linkages[3] were proposed to couple the two motions in such a way as to keep the image automatically in focus while the focal length was being varied, and the zoom lens was born.

During the late 1920's, the need for a zoom system was beginning to be felt in the motion-picture industry, and several designers suggested using a reversed telephoto lens for this purpose. One proposal was to erect a large negative lens at some distance in front of a camera,[5] the camera itself being focused on the virtual reduced erect image of distant objects formed by the negative lens. To change magnification, the negative lens was moved towards the camera, and the camera lens was progressively refocused to maintain a sharp image. Other designers used a positive lens at or near the position of unit magnification,[6] and added a front negative lens to produce a virtual image at the correct object-position for the positive component. To vary the picture size, the positive lens was moved progressively along the axis, and the negative lens was moved in and out by a U-shaped cam to keep the image in sharp focus at all times.

The chief reasons for the unpopularity of these primitive 2-lens systems were their poor definition, distortion, low relative aperture, and large physical size. Nevertheless, the growing activity in this field indicated a need which was finally satisfied adequately about 1932.

The Zoom Age Begins (1930)

The motion-picture world passed through a remarkable technological climax around 1928–1932, with the simultaneous introduction of sound, color, wide-film, anamorphosis and zoom lenses; everything, in fact, except stereo, which arrived a few years later. Unfortunately, only sound and color survived the financial depression which occurred at the same time, and over 20 years were to elapse before the other novel devices were adopted on an extensive scale.

Several new zoom lenses were announced at that time, notably the Durholz,[16] the Bell & Howell Cooke "Varo,"[11] the Busch "Vario-Glaukar,"[14,18] and the Astro "Transfokator,"[20] which was an afocal zoom attachment intended to be used in front of a normal motion-picture camera lens. These lenses represent the first known deliberately designed zoom lenses, and in every case a cam of some kind was used to hold the image in focus on the film while the focal length was being changed. Such systems are said to be *mechanically compensated.*

There was also a brief flurry of activity in zoom projection lenses about 1930. This was due to the great variety of film sizes in use at that time, from the large

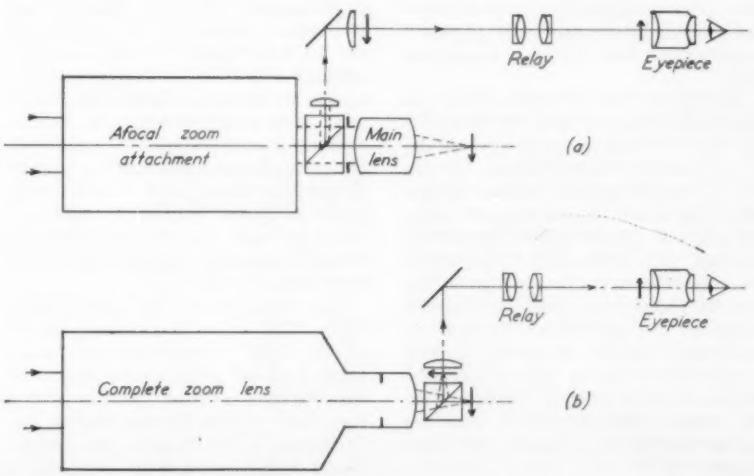


Fig. 2. Two typical forms of reflex viewfinder.

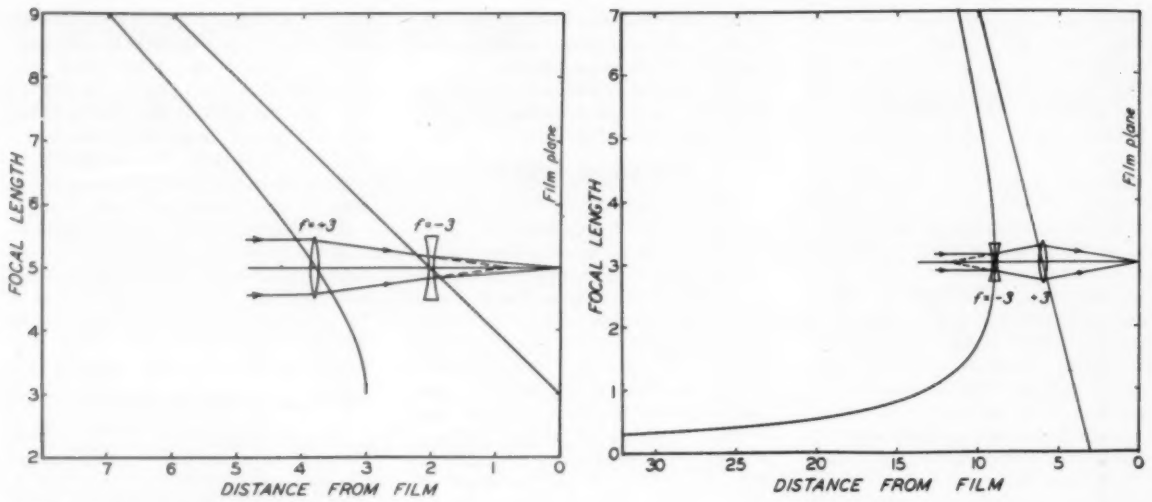


Fig. 3. The two-component zoom system.

"Grandeur" pictures on 70mm film down to the newly introduced standard 16 by 21mm sound frame. A projection lens of continuously variable focal length not only permitted all frame sizes to be projected on the same screen, but it also facilitated the "magnascope" effect in which important incidents in a film were rapidly enlarged to cover a much larger screen area than usual. A notable zoom projection lens of that period was the Busch "Vario-Neokino."[9,18]

The Zoom-Lens Renaissance (1946)

The burst of activity that began in 1930 soon subsided, and virtually nothing more was heard of zoom lenses until the introduction of the Zoomar lens for 16mm cameras by F. G. Back in 1946.[26] This lens embodied five positive components in succession, the second and fourth being coupled in such a way that they could be made to slide together along the lens axis to vary the focal length without any significant displacement of the image along the axis. The Zoomar principle was applied to a series of zoom lenses and zoom telescopes with ranges of magnification from 3:1 up to as high as 10:1.

An independent development was the Pan-Cinor, designed by R. H. R. Cuvillier in 1949[30] and manufactured by the French firm of SOM-Berthiot. In this lens, a pair of coupled positive components was made to slide together along the axis, with a fixed negative component between them, and a fixed component in the rear to form the final image on the film, the image again remaining virtually stationary during a zoom. In spite of many shortcomings which were present in the original model, this type of construction proved to be so far superior to the original Zoomar that it soon replaced the all-positive-lens type completely.

The Zoomar and Pan-Cinor lenses were examples of a new concept, namely, the *optically compensated* zoom lens. In these systems, no cam is required to hold the image in focus, as by a suitable combination of lens powers and separations it is possible to achieve a fixed image position for three or more zoom positions, the residual errors at intermediate points being generally small enough to be tolerable. However, in spite of the manifest advantages of optically compensated systems, many designers prefer to use a cam to maintain sharp focus.

Although the adoption of zoom lenses for motion-picture cameras developed slowly, the infant television industry immediately realized the advantages of the new lens. In 1946, H. H. Hopkins[33] in England designed a modified form of the single-sliding-lens system in which the sliding component was divided into two parts, the separation between them being controlled by a cam. This design was used by W. Watson and Sons, Ltd., in their 5:1 zoom lens for image-orthicon cameras. Two or three years later, the Radio Optical Research Company of Hollywood commenced manufacture of the 3:1 Electrazoom lens for television cameras, which has also been extensively used in studio work. The controls of both these lenses were electrically operated for convenient remote control and a smooth uniform movement, but some cameramen preferred a direct hand control which could be moved rapidly if required.[39] About the same time the Taylor-Hobson Varotal[32] appeared, together with several forms of the Zoomar lens.

The invention of the vidicon tube about 1950 led to the introduction of several small remote-controlled zoom lenses intended primarily for closed-circuit television systems. Notable among these were several Zoomar designs, the Wollensak T.V. Raptar, the Perkin-Elmer Auto-zoom, and the Taylor-Hobson Studio Varotal.

The Opening of the Modern Era (1956)

In 1956, a Keystone 8mm camera was announced which was equipped with a new relatively inexpensive zoom lens made by the Ednalite Optical Company[42]; it was of the single-sliding-lens type, and covered a focal-length range of 10 to 28mm very satisfactorily at $f/2.4$. This novel concept of a simple low-priced zoom lens has completely revolutionized the design of 8mm motion-picture cameras. At least a dozen similar lenses have been announced since 1956, from this country and from Japan, some of which are built in as an integral part of the camera. Indeed, the day may not be far distant when lenses of fixed focal length on 8mm cameras are as scarce as black-and-white film. Several new high-quality zoom lenses have also been announced for both 8mm and 16mm cameras, as shown in Tables I and II. As in any photographic objective, by using more lens elements the designer is better able to reduce the aberration residuals, and high-quality zoom lenses invariably contain many lens elements.

During the past two years, three large zoom lenses have been announced for use on double-frame 35mm still cameras, namely, the Voigtländer-Zoomar, the Canon and the Nikkor. One may question the use of a zoom lens on a still camera, but the convenience of having to carry only one variable lens instead of a bag full of interchangeable fixed lenses justifies this procedure, provided there is no loss of definition.

Recently several zoom projection lenses have been introduced for use on small film and slide projectors. Here again the zoom feature per se is of little value, but the possibility of matching the screen size from any convenient location of the projector would seem to justify the use of a varifocal lens, provided that the definition is acceptably sharp at all zoom positions. For this purpose, there is no real

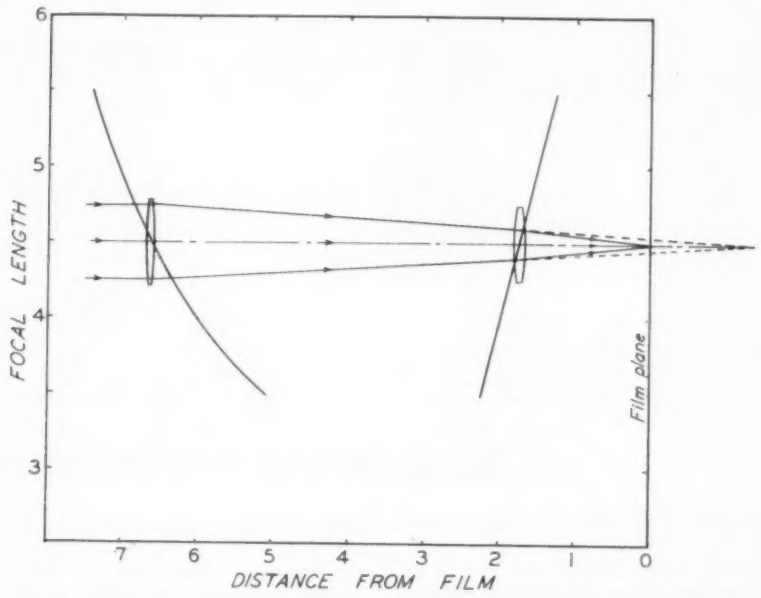


Fig. 4. The relative movements of the two positive components of a projection lens.

need to hold the image in sharp focus throughout the zoom range, and some of the recent projection lenses employ an approximate form of optical compensation, while others use a single sliding lens with no cam or other device for holding the image in focus.

Today, optically compensated zoom lenses are actively competing with the single-sliding-lens (mechanically compensated) type, and each designer has his own preference. The use of a cam results in a much better stabilization of image position during a zoom, but such a cam must be accurately constructed or it will be unsatisfactory. The cam type also involves fewer optical elements, and gives the designer a greater freedom of choice of lens powers and separations. On the other hand, the proponents of the optically compensated type point out that their mechanism is extremely simple, no cams are required, mechanical wear will cause no loss of focus control, and that by the device of moving *two* lenses between *three* fixed components the residual focus errors can be made truly negligible. However, the cost of this additional optical complexity may easily offset the economy resulting from mechanical simplicity.

THE OPTICAL PRINCIPLES OF ZOOM LENSES

Two-Component Systems

This section covers the early types of zoom lenses in which a positive and a negative component, or two positive components, are moved simultaneously at different rates by a suitable mechanism.

Suppose the powers of the two (thin) lenses are ϕ_a and ϕ_b, their separation being d. Then the power of the combination, ϕ, the image-distance from the rear lens, B, and the image-distance from the front lens, F, are related in the following way:

$$\phi = \phi_a + \phi_b - d\phi_a\phi_b$$
$$B = (1 - d\phi_a)/\phi = 1/\phi_b - \phi_a/\phi\phi_b$$
$$F = B + d = (1 - d\phi_a + d\phi)/\phi$$

To simplify our ideas, we will suppose that the two lenses have equal and opposite focal lengths, so that they would neutralize each other if placed into close contact. Then we may write $\phi_b = -\phi_a$, and our power formula becomes simply $\phi = d\phi_a^2$. In this case, the distance F from the front lens to the image passes through a minimum value when $d\phi_a = \pm 1$, or when the separation is equal to the absolute value of the focal lengths of the two single elements.

As an example, let the focal length of the lenses be 3, hence $\phi_a = \pm 0.333$, and we may draw up tables of some typical values:

$f_a = +3$

Separation d	*Focal length* $1/\phi$	B	F
1.2	7.50	4.50	5.70
1.4	6.42	3.42	4.82
1.8	5.00	2.00	3.80
2.2	4.09	1.09	3.29
3.0	3.00	0	3.00

$f_a = -3$

Separation d	*Focal length* $1/\phi$	B	F
1.5	6.0	9.0	10.5
2	4.5	7.5	9.5
3	3.0	6.0	9.0
4	2.25	5.25	9.25
6	1.5	4.5	10.5
9	1.0	4.0	13.0
18	0.5	3.5	21.5
30	0.3	3.3	33.3

These values have been plotted in Fig. 3' with focal length as ordinate and the lens positions as abscissas. In both graphs it will be noticed that the locus of the rear lens is a straight line, because B varies linearly with the focal length $1/\phi$.

The arrangement shown in the right half of Fig. 3 is the so-called reversed or inverted telephoto lens, which has also been used as a varifocal system. In this case, there are two distinct regions in which we may work. Some of the early designers preferred to stay close to the minimum point, at which a fairly long motion of the rear positive component is coupled with a small in-and-out motion of the front negative lens.[6] (Chrétien[10] suggested dividing the positive component into two parts, and adjusting their separation by a cam to maintain sharp focus.) Others saw an advantage in working at the lower part of the curve, where the effect of a long movement of the front negative lens can be compensated by a very small motion of the rear positive lens,[5] and both motions are sufficiently close to being linear so that a cam is in many cases unnecessary. However, if this system is required to cover any useful angular field, the front negative lens has to be quite large.

Two-component projection lenses of the modified Petzval type have been converted into zoom projectors by varying the central airspace. Many pin-and-slot mechanisms[4] for providing the necessary simultaneous motions of the two positive components have been described. The Gaussian optics of a two-component zoom system have been worked out in a paper by A. Biot.[34] As the range of motion of the lenses is small, the aberration correction of such systems is fortunately not seriously disturbed by varying their separation.[8] One worker found[7] that a standard design of projection lens could be satisfactorily varied in focal length from 100mm to as much as 120mm by merely varying the central airspace (Fig. 4).

Systems With Three Separately Movable Components

Some projection-lens designers felt that better corrections could be obtained over a wider zoom range by using three positive cemented doublets, all three lenses being independently movable. One such design was the Busch "Vario-Neokino" lens designed by H. Naumann[10,18] in 1931, which was claimed to cover a range of focal lengths from 70 to 140mm at $f/2$, for a standard 35mm motion-picture projector. In this system, the two front positive components were moved linearly at different rates by helical slots in the sleeve mount, the third positive component being moved by a suitable cam-slot to hold the image constantly in focus. The front lens was also equipped with an independent focus

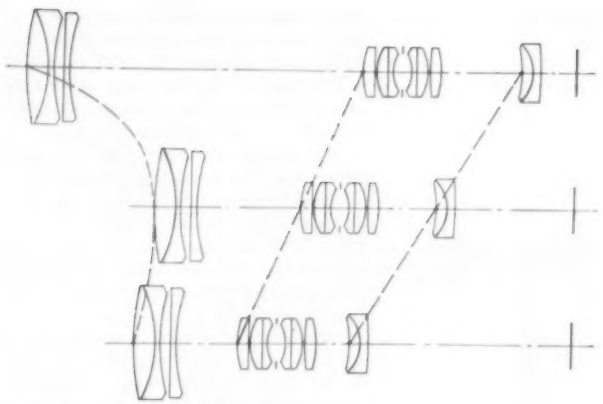


Fig. 5. The Bell & Howell Cooke "Varo" lens.

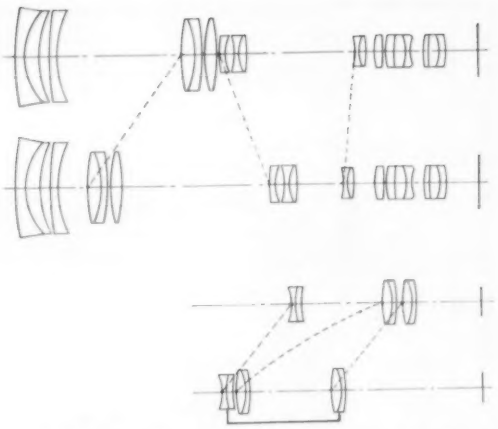


Fig. 6. Two Russian zoom lenses: "Neon-1," above; "Idar," below.

adjustment to enable the system to be operated at any specified screen distance.[10]

One of the earliest zoom camera lenses, the Bell & Howell Cooke "Varo,"[11,12] also contained three independently driven components. The middle lens was a 6-element Gauss-type objective, which moved between two movable negative components (Fig. 5). The middle and rear systems were driven linearly at different rates as the crank was rotated, but the front component required a cam to give it the correct motion to maintain focus. The mounting was very complicated, and it is fully described in the U. S. patent.[13] A series of detachable collimator lenses was supplied for focusing at near distances. The iris was mounted within the sliding positive middle component, and consequently an additional cam was required to maintain a fixed relative aperture during a zoom. A similar but somewhat simplified design was patented by Mellor & Zaugg in 1936.[21]

In a recent Russian paper,[45] two interesting zoom lenses are mentioned, the Idar (32 to 92mm, $f/3.5$ to 5.3), and the Neon-1 (35 to 193mm, $f/3$) for 35mm motion pictures (Fig. 6). In both these lenses, there are three moving components, but nothing is known about the detailed construction of the elements or the degree of correction of the aberrations.

The Single-Sliding-Lens System

The major factor which has enabled the aberrations of zoom lenses to be satisfactorily corrected was the realization by lens designers that some degree of *symmetry* is essential. The early 2-lens systems suffered from a rapid change in the aberrations as the focal length was varied. However, if a positive lens is moved along the axis between two similar fixed negatives, or vice versa, then it is possible to hold the aberration residuals reasonably constant while the focal length is varied. A fixed rear system can then be added to neutralize these constant residuals, and to give the actual focal lengths desired.

This method of varying the focal length with only a very small associated image movement was realized as early as 1902 by C. C. Allen.[2] In his lens the rear (positive) component was strong enough to form a real image on the photographic plate, and the middle (negative) element was moved along the axis by a pin-and-slot mechanism to vary the focal length. He had to move the whole system a little to sharpen up the focus, after he had set the focal length at its required value, but this was quite acceptable as Allen's lens was not intended to be a zoom system in the modern sense.

A symmetrical afocal telescope of unit power can be constructed by placing a positive lens midway between two identical negative lenses, or vice versa, in such a way that the middle lens is working at unit magnification. If the middle lens is now moved along the axis from the mid-position in either direction, the magnification will change rapidly, but the object-to-image distance of the middle lens will change only slowly. The two outer lenses are placed so that their focal points coincide with the object and image points of the moving lens, and one

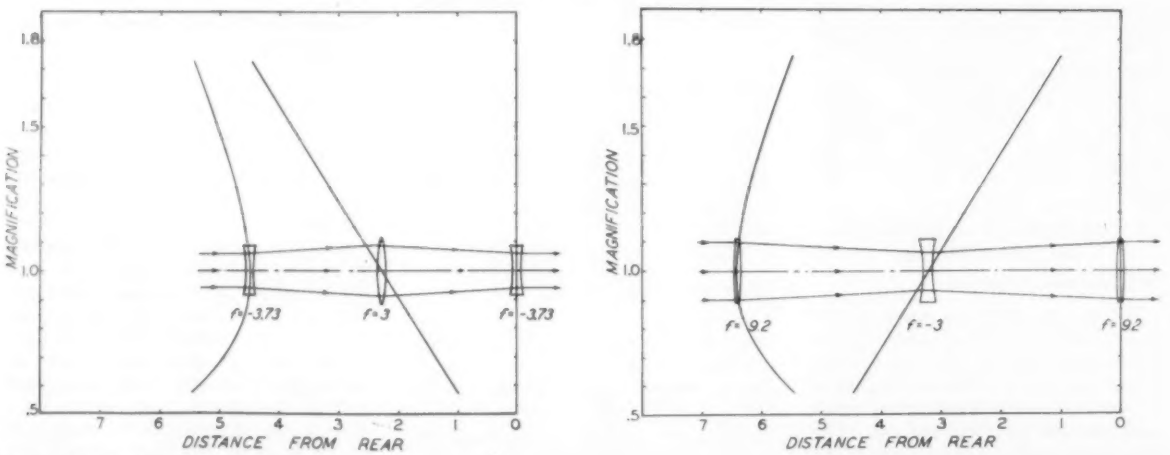


Fig. 7. The single-sliding-lens system.

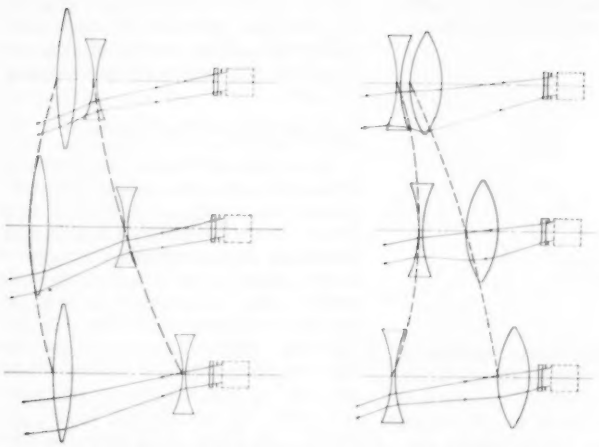


Fig. 8. Ray paths through a typical 3:1 single-sliding-lens system.

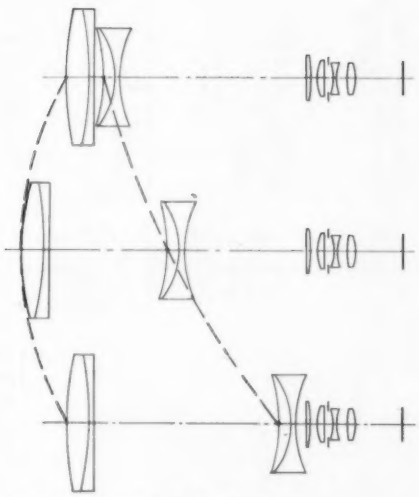


Fig. 9. The Busch "Vario-Glaukar" lens.

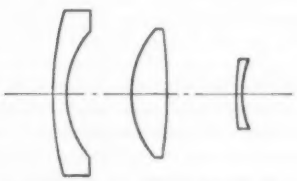


Fig. 10. The Astro "Transfokator" zoom attachment.

of the outer lenses must therefore be cam-driven to maintain the afocal adjustment of the system. This variable-power telescope can then be mounted in front of a normal camera lens to convert it into a zoom system. However, if the zoom portion is to be a permanent part of the lens, there is no virtue in making it afocal, and the rear component of the zoom system can be combined with the main lens, or with a part of it, as the designer wishes.

Assume that we have an afocal system of this type, with both outside lenses of the same focal length, f_a, the focal length of the inner sliding lens being f_b. Familiar formulas then give:

$$\text{Front lens separation} = f_a + f_b(1 + (1/m)) = (f_a + f_b) + f_b/m \quad (1)$$

$$\text{Rear lens-separation} = f_a + f_b(1 + m) = (f_a + f_b) + f_b m \quad (2)$$

$$\therefore \text{Overall length} = 2(f_a + f_b) + f_b(m + 1/m) \quad (3)$$

The necessary movement of the middle lens, b, to cover the magnification range from m to $1/m$, is therefore given by $f_b(m - 1/m)$, and the necessary in-and-out movement of one of the outer lenses, a, from the mid-position (where $m = 1$) to either of the extreme positions, is given by $f_b(m - 2 + 1/m)$. As an example, we shall select a sliding lens of focal length ± 3, and suitable outside lenses to give a unit airspace between the nearest lenses at each end of a 3:1 range of focal lengths, i.e. from $m = \sqrt{3}$ to $m = 1/\sqrt{3}$.

(*a*) *Positive sliding lens.* $f_a = -3.73, f_b = 3.$

m	*Rear space*	*Overall length*
$1/\sqrt{3} = 0.58$	1.00	5.47
0.75	1.52	4.79
1.00	2.27	4.54
1.25	3.00	4.69
1.50	3.77	5.04
$\sqrt{3} = 1.73$	4.47	5.47

(*b*) *Negative sliding lens.* $f_a = 9.2, f_b = -3$

m	*Rear space*	*Overall length*
0.58	4.47	5.47
0.75	3.95	6.15
1.00	3.20	6.40
1.25	2.45	6.25
1.50	1.70	5.90
1.73	1.00	5.47

These data are plotted on the graphs in Fig. 7. It will be seen that the motion of the middle lens is linearly related with the magnifying power of the afocal telescope, and hence also with the focal length of the complete camera system.

In Fig. 8, typical elementary 3:1 afocal zoom attachment lenses of this type are drawn, with the boundaries of the extreme oblique pencils which would exist in an ordinary 8mm motion-picture camera. Since the angular field of the camera is about $\pm 12°$, the field of the combination will run from $\pm 7°$ at one end of the zoom range to $\pm 21°$ at the other. Because the effective stop of the system is outside the zoom attachment, the lenses themselves become surprisingly large as can be seen from the diagram, but putting the iris behind all moving parts has the great advantage that the relative aperture will remain constant as the focal length is varied. In practice, the single elements shown here must be replaced by cemented or compound systems; also, some degree of vignetting is always allowed, which permits us to make the lenses much smaller than these diagrams would indicate.

The Busch "Vario-Glaukar" lens, designed by H. Naumann[14] in 1931, was claimed to be the first properly designed zoom lens (Fig 9). It was intended to be mounted on a Siemens 16mm camera. The lens consisted of a variable afocal telescope of the type just described, with a sliding negative element, mounted in front of a normal triplet objective. Focusing for near object distances was accomplished by a small further movement of the front element. The focal-length range was somewhat greater than 3:1, from 25 to 80mm, and the aperture was $f/2.8$. A Busch patent of 1931[15] shows a similar afocal system followed by a much more elaborate fixed camera lens.

The Astro "Transfokator"[20] was another afocal system of variable power, which could be mounted in front of any motion-picture camera. In one form, a strong positive lens was moved along the axis between two negative lenses as in Fig. 10, but no means was provided for holding the system in afocal adjustment. Other systems have been described, in which two lenses are moved appropriately in opposite directions between two fixed lenses, to produce the desired variation in power and to keep the system afocal.

An alternative arrangement is that suggested by H. H. Hopkins[27] in 1950 and embodied in the Watson 5:1 Television Zoom Lens[22] (Fig. 11). The two outer fixed positive lenses are identical, and so also are a pair of negative lenses sliding between the positive lenses. In the mid-position, the lens becomes a fully symmetrical unit-power afocal system, and to vary the focal length both inner lenses are moved, their separation being controlled by a cam to maintain a fixed image position.[24] To keep the front lens small, the diaphragm is made to move with the inner lenses, and consequently a second cam is required to

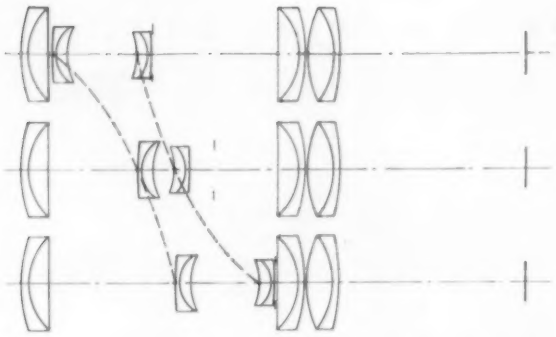


Fig. 11. The Watson 5:1 television zoom lens.

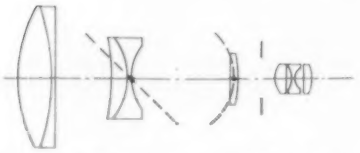


Fig. 12. Ednalite Pro-zoom Cine-8 lens.

maintain a constant relative aperture of the system. The recent Perkin-Elmer Auto-Zoom lens for vidicon cameras is of this type, and so also is the Zeiss-Ikon Pentovar lens[37] for 35mm motion pictures.

In Table I is given a list of known mechanically compensated zoom lenses.

Table I. List of Mechanically Compensated Zoom Lenses, in Approximate Chronological Order.

Approx. date	Manufacturer	Name	Focal-length range, mm	Aper.	Application	Cam-operated component	Fig.	Ref.
1931	Durholz	—	40–160	5.6–8	Cine-35	?		16
1931	Busch	Vario-Glaukar	25–80	2.8	Cine-16	front	9	14
1931	Busch	Vario-Neokino	70–140	2.0	35mm Projector	rear		10
1932	Taylor-Hobson	Varo	40–120	3.5–8	Cine-35	front	5	11–13
1932	Astro	Transfokator	(3:1)	—	—	(none)	10	20
1950	Rad. Opt. Res.	Electra-zoom	52–152	3.0	Image-orthicon	rear		29
1951	Watson	5:1 zoom lens	3–15 in. 6–30 in.	3–4.5 6–9	Image-orthicon	middle	11	27
1953	Taylor-Hobson	Varotal (I)	5–25 in. 8–40 in.	5.6 8	Image-orthicon	front		32
1955	Zeiss-Ikon	Pentovar	30–120	2	Cine-35	middle		37
1956	Ednalite	Pro-zoom	10–28	2.4	Cine-8	rear	12	43
1957	Bell & Howell	Filmovara	15–20 1.75–2.25 in.	1.5 1.6	8mm Projector 16mm Projector	(special)		
1958	A.G. Opt. Co.	Agolux	15–25	1.6	8mm Projector	(none)		
1958	Wollensak	T.V. Raptar	30–150 60–300	2.7–3.5 5.4–7	Vidicon	rear		
1958	Perkin-Elmer	Auto-Zoom 16B	30–150 60–300	3.5 7	Vidicon	middle		
1958	Angénieux	Model 70 (L-1)	17–68	2.2	Cine 16	rear	13	42
1958	Walz	Zoom Projector	16–22	1.5	8mm Projector	(special)		
1959	Taylor-Hobson	Studio Varotal (II)	22–80 2.25–8 in.	1.8 4.5	Vidicon Image-orthicon	front		25
1959	Ercsam	Polyfoc	8–20 12–30 23–50	1.9	Cine 8	(none)		50
1959	Bell & Howell	Varamat	9–27	1.8	Cine 8	front		
1959	Bell & Howell	Filmovara	3.5–4.5 in.	3.5	Slide Projector	(none)		
1959	Angénieux	K-1	9–35	1.8	Cine 8	rear		
1959	Angénieux	B-1	15–25	1.5	8mm Projector	(none)		
1960	Canon	Zoom	45–200	2.8	Minecam	rear		
1960	Canon	C-8 zoom	10–40	1.4	Cine 8	rear		51
1960	Bell & Howell	Filmovara	15–25	1.2	8mm Projector	(none)		
1960	Schneider	Variogon	10–40	2.8	Cine 8	?		
1960	Taylor-Hobson	Varotal III	4–20 in. 8–40 in.	4 8	Image-orthicon			

Where two focal-length ranges are given, the fixed rear portion of the lens is interchangeable. Other systems of this type have been described in the patent literature.[22,28]

Optically Compensated Systems

The original Zoomar: In this system, the front objective lens (which is interchangeable) forms an inverted real image. This is relayed by a fixed erector system to form a second (erect) real image, which is in turn re-imaged by another fixed relay system to form the final inverted image on the film (Fig. 14). A sliding "variator" lens moves past the first real image, while a coupled "compensator" or field lens moves at the same rate past the second real image, the powers and spaces being chosen so that the final image moves only slightly back-and-forth. This lens was manufactured in several sizes. The first was the 16mm Zoomar covering a 3:1 range of focal lengths (17 to 53mm) at $f/2.9$; it was followed by the 35mm Zoomar covering 2 to 7 in. at $f/4.5$. These lenses have been fully described by the inventor.[28] The actual maximum focal length could be increased by interchanging the front component, at a corresponding reduction in relative aperture. A coupled viewfinder, incorporating a similar zoom system, was mounted alongside the lens to show the operator what he is photographing at all times. The fact that all the optical components were positive made the Petzval sum very great, and the off-axis definition left much to be desired. Also, the great length of the lens made it inconvenient to use.

The Pan-Cinor: In this system,[30] an afocal zoom telescope embodying four components, consecutively positive-negative-positive-negative, is mounted in front of an ordinary camera lens. The two positive lenses are coupled together, and the two negative lenses are also coupled together. Either pair can be fixed and the other pair, movable,[35] and because the system is afocal, it can be used either way round. It can readily be shown[41] that if a certain relationship exists between the powers and separations of the lenses, the image will fall in the same plane for *three* zoom positions, and the back focus will follow a cubic curve at other zoom positions. It will thus remain substantially in-focus throughout the entire zoom range, especially if the focal length is short and the range of focal lengths is not greater than about 3:1. The fundamental principle of this optically compensated system was originally proposed by Richter[17] for a different purpose, but it had not been applied to a motion-picture camera before Cuvillier's introduction of the Pan-Cinor in 1950.

The action of this 3-lens system can be understood from a consideration of Fig. 15. Suppose we have a pair of coupled

movable lenses (*a*) and (*c*), surrounding a fixed lens (*b*). Then X represents the initial distance from the anterior focus of lens (*b*) to the posterior focus of lens (*a*), while S represents the initial separation of the adjacent focal points of (*b*) and (*c*). Now we require the image to return to its initial position after moving lenses (*a*) and (*c*) to the right through a distance D, and again after moving them twice as far, through a distance $2D$.

The initial value of the back-focus, *B.F.*, from lens (*c*) to the image plane, is given by

$$B.F. = f_c + \frac{f_c^2 X}{f_b^2 + XS} \qquad (4)$$

After moving lenses (*a*) and (*c*) to the right by a distance D, the values of X and S will both be *increased* by D, but the *B.F.* must be *decreased* by D. Hence

$$D = (\text{initial } B.F.) - (\text{new } B.F.)$$
$$= \frac{f_c^2 X}{f_b^2 + XS} - \frac{f_c^2 (X + D)}{f_b^2 + (X + D)(S + D)} \qquad (5)$$

We also require this relation to hold if D is replaced by $2D$. After making this change and subtracting one relation from the other, we get

$$f_c^2 X = (f_b^2 + SX)(X + S + 3D) \quad (6)$$

Substituting this into (5) gives us

$$f_b^2 = \frac{X(X^2 + 3DX + 2D^2)}{S + 2X + 3D} \qquad (7)$$

Hence if we assign arbitrary values to X, S, and D, we can solve for the value of f_b by (7) and then for f_c by (6). The value of f_a does not affect the operation of the zoom provided X is unchanged, but it does affect the actual values of the focal lengths:

$$\text{Initial focal length} = -\frac{f_a f_b f_c}{f_b^2 + XS}$$

$$\text{Final focal length} = -\frac{f_a f_b f_c}{f_b^2 + (X + 2D)(S + 2D)}$$

The focal lengths of the second and third lenses, f_b and f_c, can be either positive or negative since the formulas give only their squares. The designer has thus some latitude in his choice of lens powers and spaces, and we may expect a considerable variety in the design of this type of zoom lens.

As an example in the use of these formulas, let us assume values of $X = 2.387$, $D = 1$, and $S = -0.224$, which will give us a 3:1 range of overall focal length. Then Eq. (7) gives $f_b^2 = 4.698$, whence $f_b = \pm 2.168$. We shall use the negative value here. Also, Eq. (6) gives $f_c^2 = 9$, whence $f_c = \pm 3$, and we shall now use the positive value. By letting $f_a = 7.055$, we find the initial values of the two air-spaces to be $d'_a = 2.5$ and $d'_b = 0.608$, assuming thin lenses as usual. Computation through the basic system, and the two systems resulting from a shift of the positive lenses to the right by distances $D = 1$ and $D = 2$, respectively, give:

D	d'_a	d'_b	*B.F.*	*Focal length*
0	2.5	0.608	8.160	11.01
1	1.5	1.608	7.160	6.26
2	0.5	2.608	6.160	3.67

These results are shown plotted in Fig. 16. To demonstrate the cubic-curve motion of the final image during a zoom, we next calculate the *B.F.* for some other values of D, and add the focus-shift curve to our graph:

D	*B.F.*	*Error in image position*	*Focal length*
−0.5	8.096	−0.56	13.76
0.5	7.727	+0.07	8.35
1.5	6.622	−0.04	4.75
2.5	5.780	+0.12	2.90

If the final image is real, the system can be used directly as a zoom lens, but the focus variations between the three fixed-focus points are likely to prove excessively large if no focus cam is employed. Therefore, the zoom section is commonly designed to have a much longer focal length than is actually required, and a fixed positive rear system is added to shorten the focal length to the desired value. The added rear system has the effect of reducing the focus variations by the square of the minification-ratio at which it is working. Alternatively, a suitable negative component may be mounted behind the zoom system to make it into an afocal telescope, which is then used in front of a normal camera lens of short focal length. This also reduces the focus variations between the three fixed points.

This arrangement is often referred to as a 3-lens system because the presence or absence of a fixed rear component plays no part in the varifocal properties of the system. By a similar argument, lenses of the Vario-Glaukar type may be called 2-lens systems since they contain only two lens components ahead of any fixed rear system. In general, the greatest possible number of identical image positions is equal to the number of compo-

Fig. 13. The Angénieux 4:1 zoom lens.

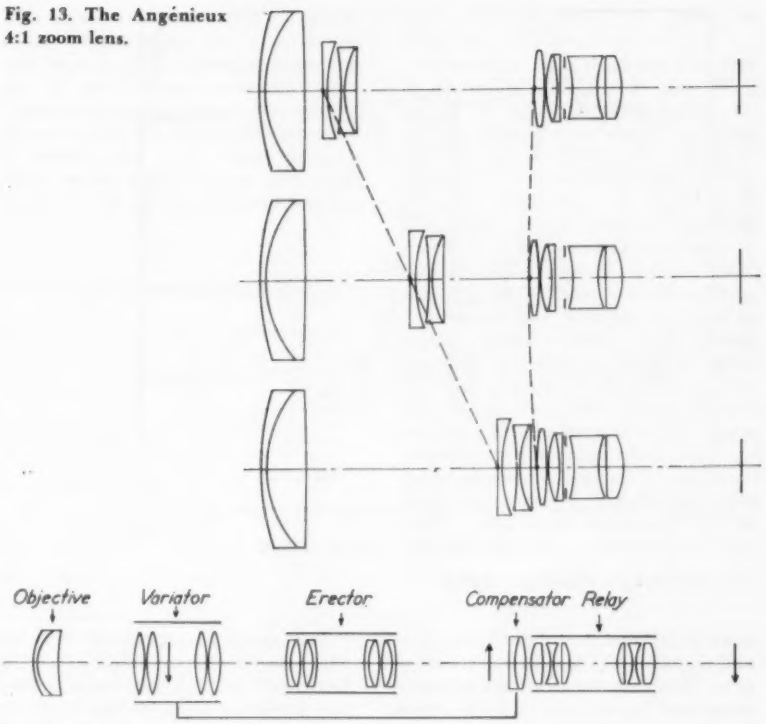


Fig. 14. The original Zoomar lens.

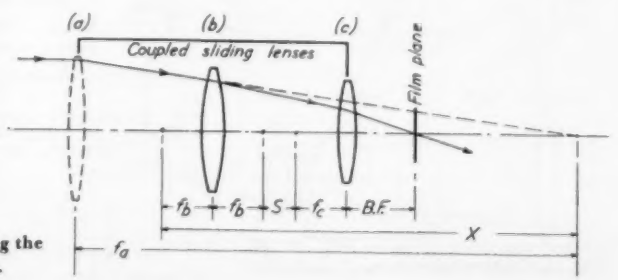


Fig. 15. Illustrating the Pan-Cinor system.

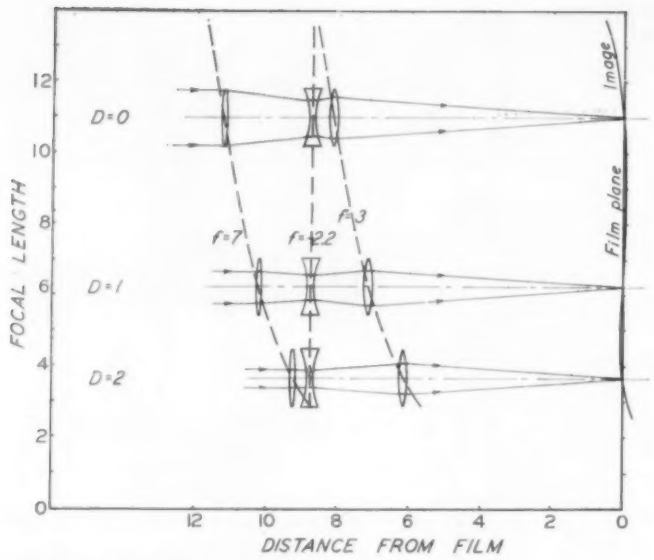
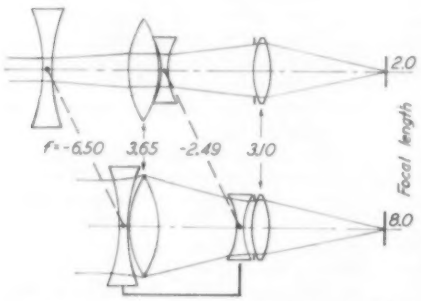


Fig. 16. The basic Pan-Cinor system.

nents in the front part of the system up to and including the last movable component. Thus a 2-lens system has a parabolic image-shift curve, while a 3-lens system has a cubic focal locus. The residual errors of the 2-point or parabolic locus are generally so large that a cam must be used to hold the image on the film, and in some cases a cam may prove to be desirable even with a 3-point or cubic locus. There is thus no absolute distinction between mechanically and optically compensated zoom systems.

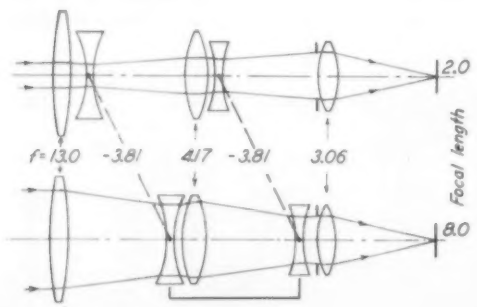
The optically compensated zoom system was enormously improved by L. Reymond[39] in 1953. He realized that if two similar coupled sliding lenses are made to move between three fixed lenses of opposite power to that of the sliding lenses, then it is possible to secure a constant image plane at four selected zoom positions instead of the usual three. As the zoom part of the system lying in front of any fixed rear component now embodies four lenses it is often referred to as a 4-lens system.



3-Lens System, Fig. 17.

Movement	*Focal length*	*Image shift*
0	2.00	0
0.75	2.88	+0.0338
1.50	4.12	0
2.25	5.77	−0.0676
3.00	8.00	0

Fig. 17. A 3-lens 4:1 system with sliding negative elements.



4-Lens System, Fig. 18.

Movement	*Focal length*	*Image shift*
0	2.00	0
0.5	2.52	+0.0009
1.0	3.18	0
1.5	4.00	−0.0009
2.0	5.04	0
2.5	6.34	+0.0023
3.0	8.00	0

Fig. 18. A 4-lens 4:1 system.

The great practical advantage of this arrangement can be seen by comparing the similar 3-lens and 4-lens systems shown in Figs. 17 and 18. In both systems the two coupled negative lenses move through a distance of 3 units to produce the same 4:1 change in focal length from 2 to 8 units. The powers of the individual lenses are closely similar and so are the overall lengths of the systems. Yet the residual focus errors in the older 3-lens system are about 30 times as great as in the 4-lens system, as shown in the tabulations accompanying Figs. 17 and 18.

This type of construction has been used in the Pan-Cinor 70 and Pan-Cinor 100 lenses by SOM-Berthiot, and also in the recent Voigtländer-Zoomar lens for 35mm miniature cameras,[47] in which the focal-length range is only 2:3 to 1, but exceptionally good focus control is required (Fig. 19). The general theory of systems of this type has been given by Bergstein.[41b]

It might be thought that each of the components of the zoom portion of a lens would need to be separately achromatized in order to secure adequate correction of both longitudinal and lateral chromatic aberrations at all zoom positions. The situation has been discussed by M. Reiss,[53] who pointed out that if one lens is assumed to be a singlet made of a known glass, then we can calculate the best possible equivalent dispersive powers for the other two lenses. By chance, one of these may lie within the range of dispersions of available glasses, in which case that lens also can be a singlet, as in the recent Wollensak zoom lens designed by Turula and Lynch.[46]

A list of the known optically compensated zoom lenses is given in Table II. There have also been many patents[36,52] covering lenses of this general type.

PRISMATIC ZOOM SYSTEMS

It was known to David Brewster in 1810 that a refracting wedge or prism of glass held before the eye in the minimum deviation position would give an undistorted visual image with a minimum but significant angular deviation, and the image would have colored fringes due to color dispersion. However, if the prism is then rotated about an axis parallel to the refracting edge of the prism, the deviation increases, and the image will become anamorphically compressed when the prism

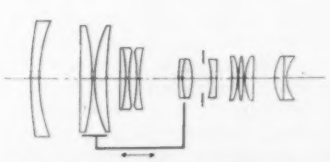


Fig. 19. The Voigtländer-Zoomar lens.

is rotated one way, or stretched if rotated in the opposite direction. By the use of two prisms in succession, with parallel refracting edges, rotated by equal and opposite amounts from the minimum deviation position, the deviations and color dispersions will approximately cancel, but the anamorphic compression or stretching will be doubled (Fig. 21). This system thus constitutes a variable afocal anamorphoser which could be used in front of a camera or projection lens to give an anamorphically compressed or stretched image. The amount of anamorphic deformation can be varied by rotating the prisms about the axes shown by the small circle on each prism in Fig. 21, the position of the middle ray then remaining fixed throughout the whole range of prism rotation.

If, now, two such prism pairs are used in succession, the second pair being turned 90° about the line of sight, the same compression or stretching would exist in both meridians, resulting in the appearance of normal telescopic magnification or minification.[31] By coupling all four prism axes together we can thus construct an ingenious variable-magnification afocal telescope without using anything other than these four prisms. This can be then mounted in front of an ordinary camera lens to make a zoom lens.[49] Because these tilted prisms introduce a large amount of astigmatism if the light beam is not strictly parallel, it is necessary first to focus the camera lens accurately on infinity, then place the prism system in front of it, and lastly place a collimator in front having a focal length equal to the distance of the object. (A focusing collimator is ideal here.)

Table II. List of Optically Compensated Zoom Lenses, in Approximate Chronological Order.

Approx. date	Manufacturer	Name	Focal-length range, mm	Aper.	Application	No. common focal points	Fig.	Ref.
1946	Res. and Dev. Labs.	Zoomar	17–53	2.9	Cine-16	?	14	26
1947	Res. and Dev. Labs.	Newsreel Zoomar	75–250 150–500	4.5 9	Cine-35	?	14	26
1947	Res. and Dev. Labs.	Field Zoomar	75–325 127–550	5.6 9.5	Image-orthicon	?	14	
1950	SOM-Berthiot	Pan-Cinor	20–60	2.8	Cine-16	3		30
1953	Zoomar	Zoomar 16	25–75	2.8	Cine-16	3		36
1953	Zoomar	Studio Zoomar	63–178	2.8	Image-orthicon	3		
1954	SOM-Berthiot	Pan-Cinor 36 60	12.5–36 20–60	2.8 2.8	Cine-8 Cine-16	3		
1954	SOM-Berthiot	Pan-Cinor 70 100	17.5–70 25–100	2.4 3.4	Cine-16	4		38
1954	Zoomar	Zoomar 8	13–39	2.8	Cine 8	3		
1955	Zoomar	Universal Zoomar	63–406	3.9	Image-orthicon	?		
1956	Zoomar	Zoomar 35	40–120	2.8	Cine-35	3		
1956	Zoomar	Zoomar II	22–130 35–210	3.5 5.6	Vidicon	?		
1956	Zoomar	I.T.V. Zoomar	20–120	3.9	Vidicon	?		
1957	SOM-Berthiot	Pan-Cinor 35	38–154	2.4	Cine-35	4		
1957	Zoomar	Super Studio Zoomar	57–180 127–380	2.7 5.6	Image-orthicon	?		
1958	Zoomar	Zoomar MK-IV	17–70 30–125	2.0 2.8	Vidicon	?		
1958	Zoomar	Super Universal Zoomar	57–406 101–635 165–1016	3.9 5.6 8	Vidicon	?		
1958	Zoomar	Zoomar MK-VI	25–150 40–240	3.5 5.6	Vidicon	?		
1959	Voigtländer	Zoomar	36–82	2.8	Minecam	4	19	47
1959	Wollensak	Raptar Zoom	9–30	1.8	Cine-8	3	20	46
1959	SOM-Berthiot	Pan-Cinor 85	17–85	2.0	Cine-16	?		48
1959	SOM-Berthiot	Pan-Cinor 30 L	10–30	2.8	Cine-8	3		
1959	Kodak	Zoom lens	8.5–24	1.9	Cine-8	3		
1959	Elgeet	Vari-Zoom	9–27	1.8	Cine-8	?		
1959	Wollensak	Projection Zoom	15–25	1.5	8mm Projector	3		
1960	SOM-Berthiot	Pan-Cinor 150	38–150	3.8	Cine-16	4		

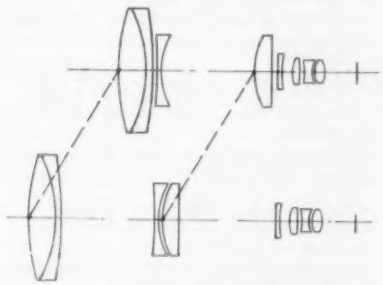


Fig. 20. The Wollensak Raptar Zoom lens.

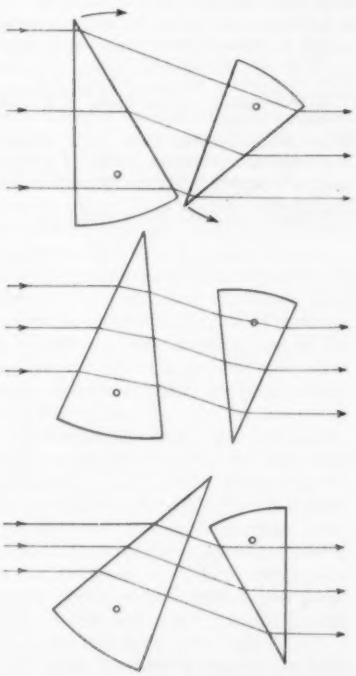


Fig. 21. The prismatic zoom attachment. Telephoto, above; wide-angle, below.

Table III. Recent Zoom Lenses of Unknown Construction.

Approx. date	Manufacturer	Name	Focal-length range, mm	Aper.	Application	Ref.
1959	Zeika	Zoom Nominar	13–38	2.8	Cine-8	
1959	Nippon Kogaku	Nikkor Tele-Zoom	85–250	4	Minecam	49
1959	Konishiroku	V-Hexanon	12–32	2	Cine-8	
1960	Elmo	Zoom	10–30	1.8	Cine-8	
1960	Sun	Zoom Lens	10–30	1.8	Cine-8	

This system has the great advantage that it introduces no aberrations of any kind into the image except a little lateral color, which can be removed by achromatizing the prisms, and some unusual types of distortion of small magnitude. However, the prisms are liable to become large and expensive, and the angular field is limited to about $\pm 8°$, which is less than most zoom lenses of normal type will cover. The design of such a system has been fully described by Luboshez.[40]

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Optical Printing of Liquid-Coated Negatives at Technicolor

By HENRY O. IMUS
and JOSEPH W. SCHMIT

Surface grain and abrasion defects emphasized in optical printing from single-strip color negative for wide-screen presentation were formerly minimized by means of lacquer coatings and diffuse printer optics. This method resulted in lacquer dirt and loss of definition. Technicolor matrices of greatly improved quality are now printed from "wet" negatives, i.e., the negatives are run through a perchlorethylene bath, doctored by means of air and/or vacuum squeegees, printed, then dried by air jets before being taken up.

Before the advent of single-strip color negative, the color motion-picture processing laboratories were confronted with numerous negative difficulties. However, they had not yet been faced with the requirements of negative lacquer coatings, nor the need for diffusion in optical printing from a picture negative. As the three-strip color camera was gradually superseded during 1953 and 1954 by single-strip cameras using Eastman color negative and other color films, the magnitude of the dirt and grain problem introduced by the new types of color negative became apparent, particularly in optical printing. Its seriousness was further intensified by the increasing use of wide screens with their demands for more picture information per unit area of film.

At this stage Technicolor started a technical investigation of the dirt and grain problem. These studies revealed that dirt and grain at the screen, caused primarily by surface defects, could be reduced considerably by a coating of lacquer applied to the negative. A further requirement was the use of diffusion on the optical printer. However, these solutions to the problem of dirt and grain introduced new problems. The lacquer proved troublesome to apply, and picked up dirt on its surface that could not be easily removed. It flaked at the bead edge, causing more dirt. This required multiple removals and re-applications of lacquer during the printing life of the negative. The diffusion glass, necessarily placed close to the negative aperture, picked up lacquer flakes which produced many printer spots. Moreover, the use of diffusion reduced print definition, which was undesirable in view of the trend to wider screens.

It soon became evident that a different approach was needed in order to eliminate the "dirt" without impairing the definition of the print. Technicolor then turned to the idea of solving the dirt and grain problem by printing from a "wet" negative. Such a procedure, if workable, would eliminate from the picture substantially all negative surface defects. The principle of using a wet coating to eliminate the effect of scratches has been known for many years and had been demonstrated in the printing of still pictures.[1] It had not yet, however, been applied commercially to the printing of motion pictures. Development work at Technicolor extended through the years 1955 and 1956, and wet printing was put into production on a developmental basis in April 1957. Twenty million feet of imbibition prints from wet-printed matrices were released during 1957. As more matrix printers were converted to wet printing in 1958, the figure increased to 100 million feet. By 1959, practically all of the imbibition footage was produced from wet-printed matrices.

The matrices required for this production, as well as some color positive prints, come from some thirty-five different printers, covering all the conceivable types of optical printing required by the customers. These printers print from 65mm to 35mm, from double-frame to single-frame 35mm or 16mm, from 35mm to 35mm, and from 35mm and 16mm to 16mm single or double rank. Some printers print without anamorphic changes and some print with varying degrees of anamorphic changes. Technicolor-affiliated plants in London and Rome are similarly equipped with wet printers.

Description

This complexity of the matrix printing requirements made it necessary to develop a wet method applicable to the whole group of printers and their facilities. When considering the different possibilities in wet printing, total immersion of the negative movement came first to mind. This was excluded in the initial investigations because it would have required new negative movements for more than thirty printers. The wet printing method that was adopted by Technicolor, the "open face" method, involved a minimum modification to the gate assembly and was otherwise more readily adaptable to the particular printers involved, all of them being variable speed, optical, step, registering printers. Concurrent investigations at Eastman Kodak Co. on submerged movements and liquid gate printing have been reported on previously.[2]

In the process at Technicolor the negative is run through a solution dip tank on the printer. It is doctored with air and/or vacuum and seated wet in the printer aperture. It is then taken up through a blow-off drybox in a clean, dry condition. Threading guards are provided on every wet printer to prevent any accidental misthreading of negative through the equipment.

The liquid used to wet the negative must be completely safe for personnel, customer's negative, and equipment. It must have the proper index of refraction to cover grain and other surface defects of the negative. It must strip from the negative easily before take-up without leaving any residue. Finally it must be readily obtainable commercially. After an extensive investigation of many possible liquids and mixtures, perchlorethylene was finally selected as the liquid having the best combination of properties to meet these various requirements. Since this is a nonaqueous liquid, there is no appreciable penetration into the gelatin overcoating of the negative. The negative appears "wet" as it prints but the liquid coating is just on the surface and is easily blown off in the drybox. Exhaustive tests were conducted to determine the effect of perchlorethylene wet printing on black-and-white and color negatives. Test strips of film were immersed in the liquid for as long as 72 hours, and test loops were printed for hundreds of cycles. There was no evidence of any deterioration of the base or dye layers in any of these films either immediately after the tests or after extended storage.

Experience has shown that surface defects are found on both the base and emulsion sides of the film. The refractive index of perchlorethylene, 1.504, is midway between that of triacetate base, 1.478, and that of the gelatin overcoating on the emulsion, 1.52, and covers most surface defects on both sides. Other properties of this and other possible liquids have been tabulated previously.[3]

Although perchlorethylene is less toxic than most organic solvents, rigorous control of its vapors is maintained on the printers and in the printing rooms. The

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(This paper was received on July 11, 1960.)

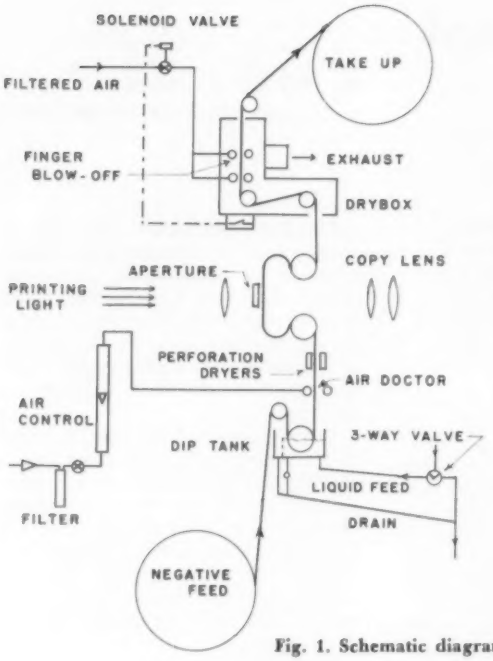

Fig. 1. Schematic diagram of a typical wet printer.

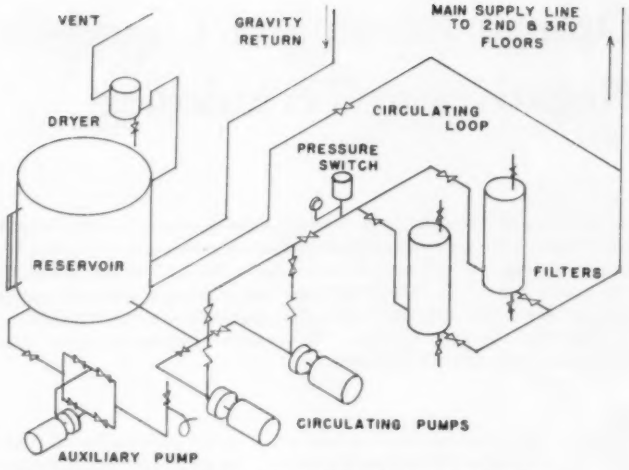

Fig. 2. Schematic diagram of perchlorethylene pumping station.

installation of vapor control equipment constituted a large portion of the expense in instituting the wet-printing program, and was guided in part by officials of the State Board of Health. Periodic analyses are made of the air in the printing rooms.

Figure 1 is a schematic diagram of a typical wet printer. The negative is first immersed in the liquid, then is passed through an air doctor which controls the amount of liquid remaining on it. The negative is seated wet in the printing aperture and is then taken up through a blow-off-type drybox. The air to the doctor knives is metered to accommodate different printer speeds. A switch on the door of the drybox turns on the drying air when the door is closed. The entire negative path from feed to drybox is enclosed to control vapors and to keep dust from the negative and the film transport mechanisms. The vapors are exhausted from the drybox into a duct along the base of the room walls which also exhausts any stray vapors from the room.

Perchlorethylene Circulation

Originally, the liquid was fed to each printer from individual bottles in a constant-level feed. Recently, a central feeding system has been installed which saves much time and labor, and with the washing action of the constantly flowing liquid, a further reduction in print dirt at the screen has resulted.

Figure 2 shows schematically the pumping station for the liquid feed system. The circulating pumps are interconnected by a pressure switch which starts the second pump if the one in operation should fail. A time delay in the circuit prevents the pressure switch from operating at start-up until the system has reached its normal operating pressure. The two filters are used alternately to permit changing the cartridges while the system is in operation.

Figure 3 is a schematic drawing of the circulating system to the printing rooms. A three-way valve at each printer location channels the liquid through the printer or to a by-pass line. Both lines have an orifice to regulate the flow. Reserve tanks on each floor permit the continuing of printing operations up to several hours in case of total pump failure. Routine tests are made on the circulating liquid for moisture and nonvolatile residue, and periodic checks are made on pH and copper corrosion.

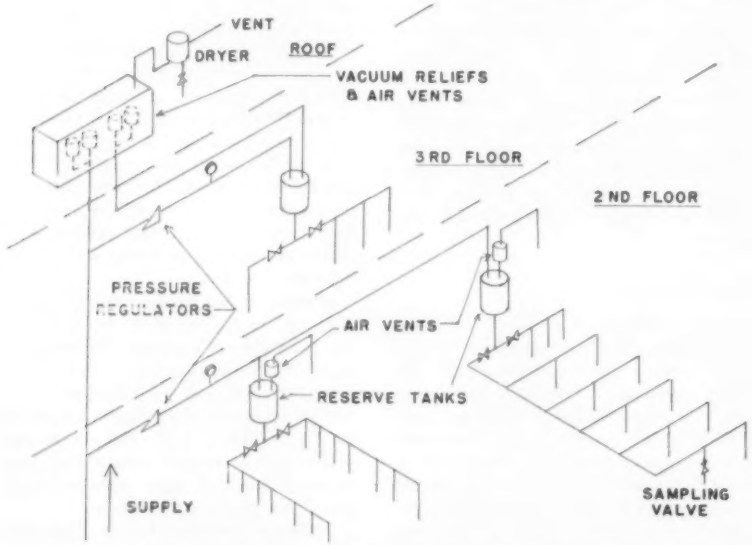

Fig. 3. Schematic diagram of perchlorethylene distribution system. (Gravity return lines not shown.)

Conclusions

For Technicolor, wet printing has many advantages. Negatives are now printed with a minimum of delay, since lacquering and subsequent de-lacquering, and then re-lacquering are no longer necessary. The only requirement before wet printing is that the negatives come to the wet printers in a clean condition. To insure this, use is made of an ultrasonic cleaning machine, or manual wet cleaning in the case of 65mm negative.

Four years experience has shown that there is less printer damage to wet-

printed negatives, since the liquid coating serves as a lubricant to protect the surfaces better than did the previous lacquer coatings. There is also less perforation wear and less negative aperture dirt.

There has been a major improvement in the quality of prints, obtained primarily through reduction of the dirt and grain level with wet printing. This was, of course, expected because early investigations disclosed that the major contributions to dirt came from surface abrasions that lacquer failed to cover in optical printing and also from lacquer flaking.

An unexpected improvement has been the increased printing-through in highlight areas. Formerly, in dry optical printing from unlacquered negatives with a matte surface, as much as three points of printing could be lost due to the scattering of light by the matte surface, especially in the heavily exposed areas. The use of lacquer, of course, greatly reduced this loss. Now, however, with wet printing, the highlight detail prints through to an even better advantage, because this loss of printing light is eliminated completely by the liquid coating. It is believed that the result is a much more pleasing print at the screen.

Acknowledgment

The authors wish to acknowledge the contributions of various members of the Technical, Engineering and Research staffs in the experimental and design work. The encouragement of the Plant Administration was also a major factor contributing to the success of the program.

References

1. U.S. Pat. No. 2,890,621 issued to C. G. Suits, June 16, 1959.
2. J. G. Stott, G. E. Cummins and H. E. Breton, "Printing motion-picture films immersed in a liquid – Pt. I: Contact printing"; J. R. Turner, D. E. Grant and H. E. Breton, "Printing motion-picture films immersed in a liquid – Pt. II: Optical printing," *Jour. SMPTE 66:* 607–615, Oct. 1957.
3. D. A. Delwiche, J. D. Clifford, and W. R. Weller, "Printing motion-picture films immersed in a liquid – Part III: Evaluation of liquids," *Jour. SMPTE, 67:* 678–686, Oct. 1958.

Errata

April 1960, Part II

The following were inadvertently omitted from, or incorrectly printed in, the *Membership Directory:*

On p. 7, under **West Coast Subcommittee on Use and Handling of Film in Television:**
Add to Members: **Harry Lehman**

On p. 7, add the following Subcommittee under **Education Committee:**
Motion Picture Production
John R. Sullivan, *Chairman*, Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38

Mark Armistead	Glen Glenn	Walter Kisner
Herbert E. Farmer	M. A. Hankins	Homer O'Donnell
John Flory	Neal Keehn	Eddie Richard

On p. 24, col. 2, under **Bateman, Charles G.:**
For: Film Editor, Capital Film Labs.,
Read: Director of the Motion Picture Div., Haycox Photoramic, Inc.

On p. 32, col. 3, under **Dreisinger, Frank W.,**
For: Tech. Service Manager, General Electric Co., X-Ray Dept., 4855 Electric Ave., Milwaukee 1, Wis. (M)
Read: Consultant Technical Service, Packer X-Ray Corp., 25 South Broadway, White Plains, N.Y. (M)

On p. 36, col. 3, under **Goetz, Jack M.,**
For: Dir. Public Relations, Consolidated Film Industries. Mail: 147 Via Los Miradores, Redondo Beach, Calif. (A)
Read: Sales Administrator, Consolidated Film Industries. Mail: 1148 San Ysidro Dr., Beverly Hills, Calif. (A)
Also add to Geographic Listing, p. 69, col. 3, under Beverly Hills: **Goetz, J. M.,** and *delete* under Redondo Beach on p. 71.

On p. 57, col. 2:
Add: **Rybka, Walter,** Sales Engineer, American Speedlight Corp. Mail: 8 Norman Ct., Glen Cove, N.Y.

On p. 60, col. 3, under **Solow, S. P.,**
Add to title: General Manager
Also add to Geographic Listing, p. 69, col. 3, under Beverly Hills: **Solow, S. P.**

On p. 86, in **Sustaining Members** listing,
Add: **Comprehensive Service Corporation,** 245 West 55 St., New York 19, N.Y. (Also: 6674 Santa Monica Blvd., Hollywood 38, Calif.) The Comprehensive Service Corporation distributes an extensive line of motion-picture equipment, accessories and supplies. The firm also offers a variety of services to meet the special requirements of its world-wide clientele. The business has exhibited a steady growth since its establishment several years ago.
Address inquiries to: *the address above.*

May 1960

"*Progress Report*"

On pp. 337 and 338, in the titles of Figs. 70, 71 and 72 (credit lines),
For: Vigue Films
Read: Film and Dubbing Productions Inc.

June 1960

"New Type of Make-up Material for Color Motion Pictures and Color Television," by H. Seki and A. Kodama, pp. 414–420:

On p. 414, col. 2, line 10,
For: Yō-Ki-Hi, read: Yang-Kuei-Fei

On p. 414, col. 2, line 13,
For: Akō-Rōshi, read: Lordless samurais of Akō

On p. 419, in the title of Fig. 15,
For: One of the most ideal make-up systems:
Read: Diagram of an ideal system of make-up:

INTERNATIONAL CONGRESS 1960 5TH SMPTE ON HIGH-SPEED PHOTOGRAPHY

Sheraton-Park Hotel, Washington, D.C., October 16–22

Papers Program

The importance of high-speed photography in research is well illustrated by the technical papers received for the Fifth Congress. Eighty per cent of the authors are from research activities, while the remainder represent the engineering and developmental aspects of private industry. Of the 80 per cent engaged in research, 40 per cent are employed by government agencies in the U.S. and abroad.

While the Fifth Congress has been in preparation many inquiries have come in from universities, government institutions and commercial manufacturers for help in solving specific problems in their research and development programs. Undoubtedly, the wide variety of equipment, techniques and personal experience represented at the Congress will provide a basis for solutions to many of these.

For example, there have been many requests for information on microscopic high-velocity cutting action. At least five papers to be presented will be helpful in this regard, and access will be available to approximately ten individuals who have devised instrumentation systems adaptable for this purpose. Also, interest has been expressed in the photography of non-Newtonian liquids, the formation of droplets and the atomization of liquids; no less than ten papers from European and American research activities deal with developments related to such techniques.

Nor will the actual papers presented be the only means of help on specific problems: among the general registrants at the Congress, in addition to the authors of papers, will be many whose accumulated years of experience can be drawn on in general or private discussion.

An announcement of the sessions of the Congress in the July *Journal* listed the majority of the papers by titles and authors. Other information has been mailed to the membership in a booklet. The Advance Program with abstracts in English, French and German will appear in the September *Journal*.

Papers From Abroad

The high degree of interest in instrumentation and high-speed photography and in the work of these International Congresses on the part of experts overseas, particularly in England, France and Germany, is shown by the large number of papers submitted from abroad. Through the hands of Dr. J. S. Courtney-Pratt, Associate Chairman for Papers From Abroad, have passed 40 of the 97 technical papers finally approved for inclusion in the program.

Most of the best known and most respected scientists in the field are represented, and many of them will be at the Congress in person to deliver their papers. One of the best known of all, Dr. Hubert Schardin, Director of the Institut Franco-Allemand de Recherches de St. Louis, France, is Deputy Chairman of the Congress and National Delegate from West Germany. Dr. Schardin's research in ballistic photography and his contribution to the Cranz-Schardin system are world famous. In recognition of his accomplishments he has been nominated to be the first recipient of a newly established SMPTE award, the E. I. du Pont Gold Medal Award, which will be presented during the Congress.

Other notable visitors from Germany will include Dr.-Ing. Frank Früngel, of the well-known firm of the same name in Hamburg, manufacturers of high-power, high-frequency stroboscopic light sources; and Dr. W. Kinder, of Carl Zeiss.

The National Delegate from France, Colonel P. Fayolle, of the Laboratoire Central d'Armement, Arcueil, has also done much work in the field of ballistic photography, particularly in connection with the use of high-voltage spark techniques. Dr. P. Devaux, another expert at the Laboratoire Central, is a specialist in range instrumentation and precise chronometry. Other contributors from France are Mlle. M. Merle and F. Canac of the Centre de Recherches Scientifiques, Industrielles et Maritimes de Marseille, where aerodynamic and jet studies are carried out; Willy Diamant of the Office National de Fonderie, concerned with the atomization of liquid fuels; C. Veret and Michel Philbert of the Office National d'Etudes et de Recherches Aeronautiques, working on discharge lamps and reciprocity failure; and J. Viard of the Poudrerie Nationale, engaged in explosives research and high-speed flash X-rays, and M. Cloupeau, of the Laboratoire de Recherches Electroniques de la Sorbonne.

More than a dozen papers from England have been scheduled, evidence of the considerable degree of interest there in photographic instrumentation techniques. The National Delegate, Dr. R. F. Saxe, of Queen Mary College, London University, has been responsible for much work in the area of high-voltage physics and electronic instrumentation. Dr. W. D. Chesterman, of the Royal Naval Scientific Service, was an active organizer of the Third Congress, in London, and is known particularly for his research in underwater and other naval applications of high-speed photography. He is chairman of the U.K. Committee on High-Speed Photography and the author of a book well-known in the field, *Photographic Study of Rapid Events*. Another English contributor, R. B. Collins, of Ilford Ltd., was editor of the *Proceedings of the Third Congress*, and also for several years editor of the *Journal of Photographic Science*.

The Atomic Weapons Research Establishment at Aldermaston, Berks, where ultra-high-speed, rotating-mirror cameras are in use, is sending several representatives including E. W. Walker, whose field covers high-voltage X-ray equipment and high-speed Kerr-cells, and K. R. Coleman, A. Skinner and George H. Lunn. From the National Physical Laboratory at Teddington will come R. J. North, active in schlieren and interferometric work in connection with aerodynamic and wind-tunnel studies. Dr. E. J. G. Beeson, of A. E. I. Lamp and Lighting Co., will discuss xenon flashtubes and high-power lighting; and from the A.E.I. Research Laboratory, Robert A.

Continued on page 550

SPSE

SPSE Symposium on High-Speed Processing (in conjunction with the Congress) will be held on October 14 and 15 at the Shoreham Hotel, Washington, D.C. For registration information write Mr. Joseph Mangiaracina, 300 Brook Ave., Little Silver, N.J., or ask SMPTE headquarters.

Exhibit

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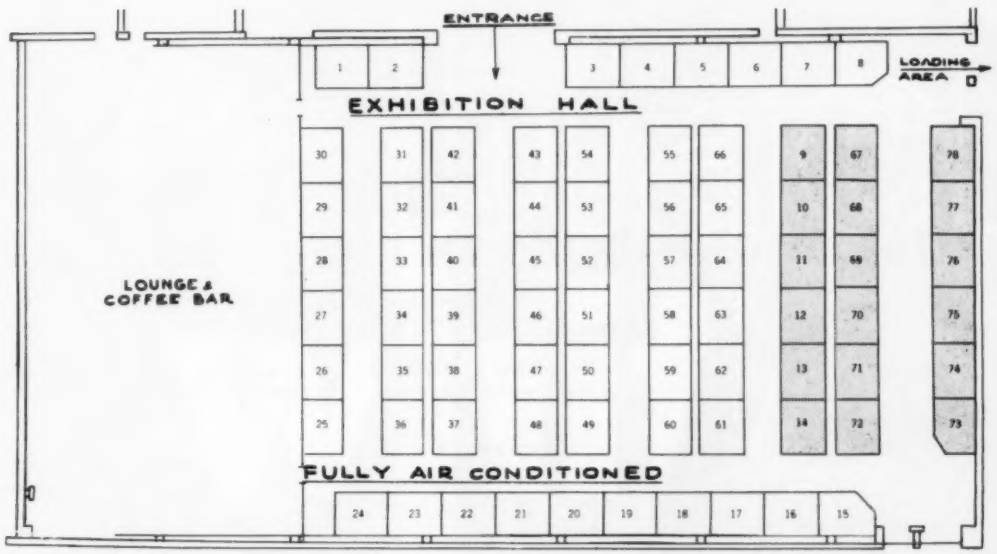

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All other booths	300

Booths 9 to 14 and 67 to 78 inclusive are being reserved for military and institutional exhibits.

All booths are 8 x 10 ft in size.

October 17–21, 1960

SHERATON-PARK HOTEL, WASHINGTON, D.C.

Chippendale and J. R. Folkes will deal with electronic image intensification.

Other authors from England whose names are well known in high-speed photography circles include Dr. J. H. Brunton, of Cambridge University; J. S. McVeagh and J. N. Whyte, of the Armament Research and Development Establishment at Sevenoaks; L. Mandell, of Imperial College, London University; and Dr. Ronald Jackson, of the British Coal Utilization Research Association.

National Delegates who will be presenting papers include Dr. G. Nahmani, from Israel, on ballistic photography; Prof. Kartar Singh, from India, on the photography of explosive gases; Dr. F. Topfer, from Belgium, on an analysis method for high-speed films; and T. Uyemura, from Japan, on a new ultra-high-speed camera.

Hotel Rates

Reservation forms are included in the brochure which was mailed earlier this month to members (additional copies are available from SMPTE headquarters); intending registrants sending reservations direct to the Sheraton-Park Hotel, Washington 8, D.C., should mention that the purpose of their visit will be to attend the Fifth Congress.

Room rates at the Sheraton-Park Hotel are as follows:

Singles — $9.85, 11.00, 12.50, 14.00, 20.00
Twins — $12.50, 13.85, 15.00, 16.50, 20.00
Suites (1 Bedroom) — $19.00, 22.00, 27.00, 35.00
Suites (2 Bedrooms) — $45.00, 55.00, 65.00

Equipment Exhibit

Those attending the Fifth Congress will find a large and varied assortment of specialized equipment displayed, covering every aspect of photographic instrumentation techniques and engineering. As an adjunct to the technical program, these displays should prove of use and interest in a general sense to those seeking new equipment and, in many cases, to those looking for engineering solutions to specific problems.

The complete list of companies participating will not be known until the Congress opens, but at the beginning of August the following companies had already reserved space:

Animation Equipment, Inc.
Arriflex Corp. of America
Avco Research & Advanced Development Div.
Beckman & Whitley, Inc.
Benson-Lehner, Inc.
Camera Equipment Co.
Computer Measurements Co.
E. I. du Pont de Nemours & Co.
Eastman Kodak Co.
Edgerton, Germeshausen & Grier, Inc.
Fairchild Camera & Instrument Corp.
Field Emission Corp.
Filmline Corp.
Oscar Fisher Co.
Flight Research, Inc.
Florman & Babb, Inc.
Dr.-Ing. Frank Früngel GmbH
General Aniline & Film Corp. Ansco Systems Development Dept.
Heico, Inc.
Karl Heitz, Inc.
Hi-Speed Equipment, Inc.
Hitachi Ltd.
L-W Products, Inc.
Motion Picture Enterprises
Neumade Products Corp.
D. B. Milliken Co.
O'Connor Engineering Laboratories, Inc.
Photo-Animation, Inc.
Photo-Sonics, Inc.
Polaroid Corp.
Precision Laboratories Div.
Prestoseal Mfg. Corp.
Sylvania Electric Products, Inc.
Traid Corp.
Westinghouse Electric Co. Lamp Div.
Wollensak Optical Co.
Carl Zeiss, Inc.
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a new SMPTE publication

CONTROL TECHNIQUES IN FILM PROCESSING

Prepared by a Special Subcommittee of the Laboratory Practice Committee of the Society of Motion Picture and Television Engineers

WALTER I. KISNER
Subcommittee Chairman

Foreword by **E. H. REICHARD**
Chairman, Laboratory Practice Committee

CHAPTERS

1. Introduction
2. General Principles
3. General Aspects of Motion-Picture Film Processing
4. Mechanical Evaluation and Control
5. Instruments for Photographic Control
6. Control Strips and Sensitometric Curves
7. Sensitometric Control of a Standardized Process
8. Chemistry of Film Processing
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Nominations for Society Offices

The Board of Governors at its meeting on July 14, 1960, approved the following slate of nominees for the Fall elections:

President: JOHN W. SERVIES

Executive Vice-President: REID H. RAY

Editorial Vice-President: LLOYD THOMPSON

Convention Vice-President: Harry TEITELBAUM

Secretary: HERBERT E. FARMER

Governors From East Coast: FRANK N. GILLETTE, WALTER I. KISNER, ROBERT C. RHEINECK, RODGER J. ROSS, MERRILL A. TRAINER, W. T. WINTRINGHAM

Governors From Central Area: JAMES J. BOSTWICK, JEROME C. DIEBOLD, KENNETH M. MASON, HENRY USHIJIMA

Governors From West Coast: Robert M. BETTY, G. R. CRANE, THEODORE B. GRENIER, ROBERT G. HUFFORD, JAMES L. PETTUS

USOE Grant to SMPTE

The United States Office of Education has awarded a $24,000 contract to this Society to plan and conduct a Conference devoted to the evaluation of the adequacy and suitability of presently available types of audio-visual equipment and devices in terms of current and future educational needs; and the formulation of engineering principles that will serve as guideposts in the development of audio-visual devices for use in education.

The two-year contract, granted in accordance with the National Defense Education Act of 1958, which spotlights a need for increased efficiency in the teaching of sciences, languages and area studies, is effective immediately.

Under the terms of the Act, the Office of Education is directed "to disseminate information concerning new educational media to state or local educational agencies for use in their public elementary or secondary schools, and to institutions of higher education." The Act specifically states that the USOE "shall make studies and surveys to determine the need for increased or improved utilization of television, radio, motion pictures, and related media of communication by state or local educational agencies and institutions of higher education for educational purposes."

According to a Society spokesman, "A fresh engineering approach to the whole field of educational communications media and equipment is called for in the light of this national emergency. Educators and engineers alike have recognized a lack heretofore of coordination."

"This study is essential," he said, "in order that the latest advances in engineering know-how are made available without delay to both the designers and the users of educational communications media and equipment."

During the proposed Conference, the Society will bring together a "task force" of outstandingly qualified experts in the fields of both education and equipment engineering. The group will include educators thoroughly familiar with the problems of methods, materials, media, curricula, building facilities, teacher training and administration. Also participating in the Conference will be engineers who have the required competency and engineering background to evaluate and to make significant recommendations in such media and equipment areas as motion pictures, television, filmstrips, slides and transparencies, recordings, teaching devices and machines.

From the transcript of the sessions of the conference the Society will prepare a report containing the conclusions reached regarding the purpose for which the conference was held. This report will be made available to the Office of Education for possible publication.

This contract is the culmination of many months of effort by the Ad Hoc Committee established by the SMPTE Board of Governors last year for the purpose of studying means by which the Society could assist in the implementation of the National Defense Education Act. John Flory of Eastman Kodak Company, Rochester, N.Y., who served as Chairman of the Ad Hoc Committee, will direct the USOE Study.

SMPTE President Norwood L. Simmons has commented on the contract: "The Society of Motion Picture and Television Engineers has long included in its aims and purposes the guidance of students and the attainment of high standards of education. We believe that the undertaking of this study for the Office of Education is one of the most important ways by which the Society may implement that purpose at this time."—*B.S.*

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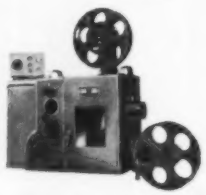

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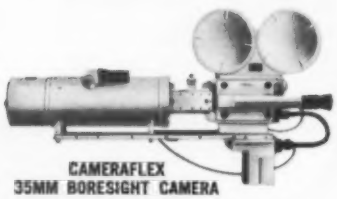

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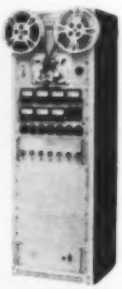

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SMPTE Lectures

Arthur E. Fury, Director of Engineering, Lux-Brill Productions, Inc., who is Chairman of the East Coast Subcommittee for Audio-Video Recording, has announced that a series of lectures on video-tape recording will be offered in the Fall.

The lectures are being designed to serve the industry's nontechnical and semitechnical personnel, including managers, directors, producers, operators and maintenance personnel, who would like to have a good knowledge of the possibilities and limitations of the medium. During the series, video tape will be defined and a video-tape system will be analyzed.

The Audio-Video Recording Subcommittee was established last Spring to determine the extent of interest in educational work in the video-tape recording field on the East Coast. Prior to the decision to conduct a lecture series, the subcommittee engaged in discussions with labor and management for their opinion of the need for such a series. A poll of users and manufacturers also indicated a high degree of interest in video-recording education.

Ampex Corporation, Radio Corporation of America and Tektronics have all offered to assist the series by supplying educational materials and the information gathered by their field engineers, who are concerned directly with the user's problems.

The proposed series of lectures on video recording follows an important series on magnetic recording, produced last Fall by the East Coast Subcommittee for the Education of Sound Technicians, under the direction of Edgar Schuller, now Education Committee Vice-Chairman.

The lectures on magnetic recording were held at Reeves Sound Studios, Metropolitan Sound Service and RCA Film Recording Studios. The success of this series has been attributed, in part, to the high-quality recording and playback equipment, the space and other facilities and the personnel, so generously made available to the Society by these companies.

To facilitate learning, training aids of various types were used in the illustration of the lectures. Each student was also given reference materials, including graphs, formulas and definitions to be used concurrently with each lecture.

Participating in the 8-week series were the following prominent men in the field: John G. Frayne, Chief Engineer, Datalab, Division of Consolidated Electrodynamics Corp.; Leroy W. Ferber, Senior Engineer, Astro-Electronics Division, Radio Corp. of America; W. Earl Stewart, Chief Engineer, The Standard Register Co.; C. J. LeBel, Vice-President, Audio Devices; Frank Comerci, formerly of the Navy Materials Laboratory, now associated with Audio Devices; Walter Erikson, Consultant; Warren R. Isom, Engineering Manager, Development Engineering Section of DEP, Radio Corp. of America; and Edward Schmidt, Vice-President, Reeves Soundcraft Corp.

Among the topics treated in this series were standards and measurement of magnetization; ferromagnetism; the recording process; the reproducing process; distortion in magnetic recording; tape and film transport mechanisms; and new developments in magnetic recording.

According to Mr. Schmidt, there have been tremendous changes in the recording media and also in recording equipment during the last three years. As a result of such changes, most of the equipment shown in the lecture on New Developments was so new that it was unfamiliar to the subscribers to the course.

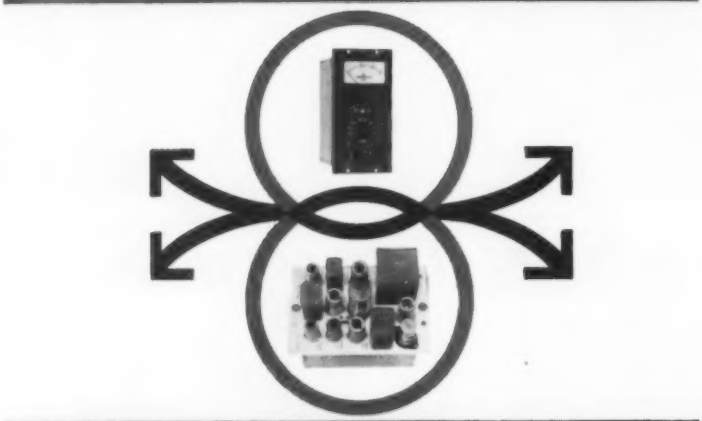
Mr. Isom brought out that although the motion-picture industry's experience was used in early designs, other industries have done a vast amount of work in developing diverse kinds of mechanisms, which according to his slides, bear little resemblance to the devices for sound recording. He emphasized great stresses exerted on tape in various data storage mechanisms and reported that tape manufacturers have met the challenge of providing increasingly improved materials.

Mr. Erikson's discussion of Distortion in Magnetic Recording contained a wealth of material on this specialized subject. In this field, there has been relatively little research. Mr. Erikson is one of the few men in this country who has done extensive research in this subject. Most of the data that he used in his talk was based on his own research or on research directed by him. Many of his graphs are unpublished except in the form of the Education Subcommittee's lecture notes. As far as the Subcommittee knows this is the first time that a lecture of this type has been presented in this country.

With the record of the success of the magnetic recording lecture series behind it, the Education Committee on the East

WESTREX COMPRESSOR AMPLIFIER AND CONTROL UNIT

for general audio-frequency use



- High degree of balance stability
- Switch selection of compression slope and threshold
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The combined RA-1593 Amplifier and RA-1594 Control Unit have been designed for maximum flexibility of operation in any audio system where the amplitude range of the original sound is greater than the useful range of the recording or broadcasting equipment.

SPECIFICATIONS

- Gain 70 db (without compression)
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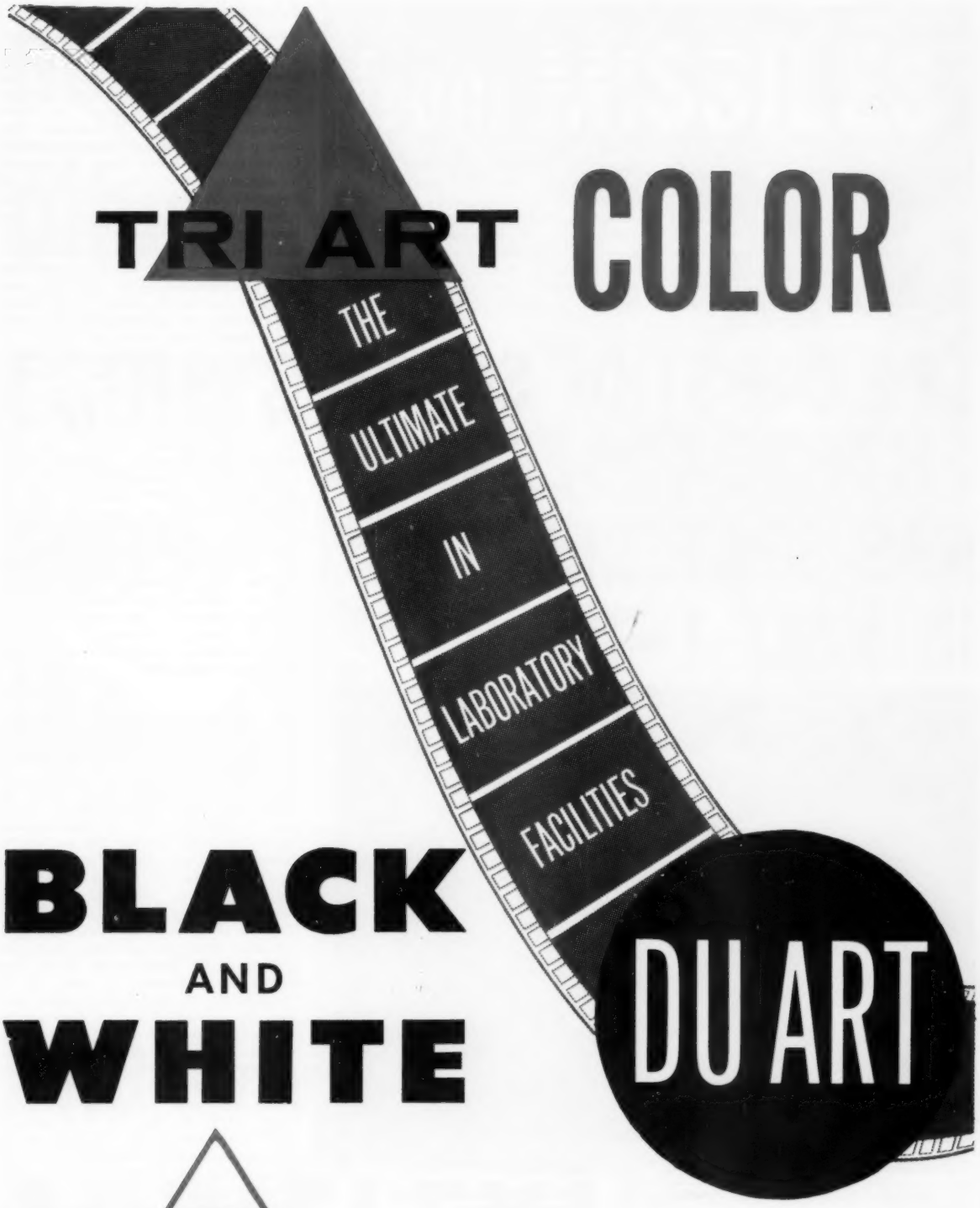

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Coast looks forward to an exceptionally high quality series on video-tape recording, according to Vice-Chairman Schuller. Further details on the series will appear in the *Journal* and by special notification of the East Coast members of the Society.—*B.S.*

Nomenclature

Terms Used in Production of 16mm Non-theatrical Motion Pictures, a glossary compiled by members of the Nomenclature Committee of the University Film Producers Association, is published in the Association's *Journal* (Winter 1960, Vol. 12, No. 2). The glossary has been revised and brought up to date from previous issues and new terms have been added. Sources consulted by the UFPA Nomenclature Committee include *American Standard Nomenclature for Motion Picture Film Used in Studios and Processing Laboratories* (sponsored by the SMPTE); *A Selected Glossary for Motion Picture Technicians, Reprint No. 23*, published by the Academy of Motion Picture Arts and Sciences; and the *Glossary* published by the Theater Arts Department of the University of California, Los Angeles. The UFPA glossary is available from The University Film Producers Association, c/o Motion Picture Division, 1885 Neil Ave., Columbus 10, Ohio. It is priced at $1.00.

THE COST OF SPRAY FILM PROCESSORS HAS JUST BEEN CUT IN HALF!

The Hi-Speed FA-50 is a new, compact spray process machine that offers all the incomparable quality features that only spray processing can produce on film . . . for less than half of what any spray machine has ever cost before.

FEATURES:

- Only 2 gallons of solution required
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- 50 ft/minute positive — black and white
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- Will process 16 mm and 35 mm, perforated and unperforated

Write today for complete technical and cost information.

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Education, Industry News

A proposal for a satellite communications system that may be ready for trial commercial use by 1965 and for development into extensive national and international systems by 1970 has been submitted to the Federal Communications Commission by Radio Corp. of America in connection with the FCC study of frequency allocations for space communications. The possibility of world-wide television by means of satellite communication is an intriguing field of scientific investigation. Services listed in the RCA statement include: intercontinental television and television service to remote areas; wide-band intercontinental communications systems; economical international and intracontinental very-high-capacity routes between major centers of population; lunar and interplanetary communications.

Advantages of international satellite relay would include: freedom from the frequent disturbances in ionospheric propagation; greater communications capacity and probably greater reliability for such classes of services as telegraph message traffic, telex services, point-to-point transmission and normal-speed radiophoto and line-facsimile messages; new long-distance record communications services such as medium and high-speed, high-definition facsimile; monaural and stereophonic program exchanges; reduced-speed television programs; and high-speed data transmission.

Both the Democratic and Republican National Conventions have been thoroughly covered in terms of political and social significance, but one or two items of a nonpolitical nature may be noted here. The General Electric Company's electronic rear-projection system, leased by TelePrompTer for use at the Democratic Convention is described in the July *Journal* (p. 514). Closed-circuit facilities for the Republican National Convention were provided by Theatre Network Television, Inc. (TNT). Four Eidophor projectors were used to project pictures of the speakers on 24 by 32-ft screens from a distance of about 220 ft. Cameras for the closed-circuit were built into the rostrum. The cameramen were hidden from the audience.

A new device used at both Conventions (first tested at the Democratic Convention) is the Vega Telemike, a wireless microphone developed by Vega Electronics Corp., 10781 N. Highway 9, Cupertino, Calif. The microphone, which is 6 in. long and weighs 8 oz, was used by American Broadcasting Co. in its coverage of both Conventions. It has its own transmitter and antenna which broadcast the signal to a pickup unit at the ABC master control.

A new company called Mitchell-Vinten, Inc., with offices in Glendale, Calif., and New York, is jointly owned by Mitchell Camera Corp. of California and the British firm, W. Vinten Ltd. The new company was formed to promote sales of Vinten products in the United States.

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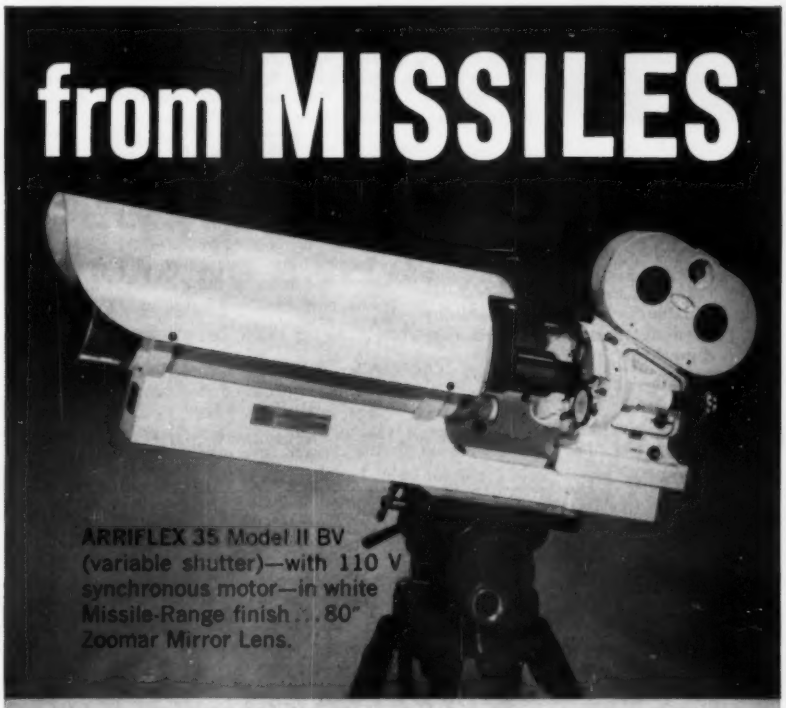
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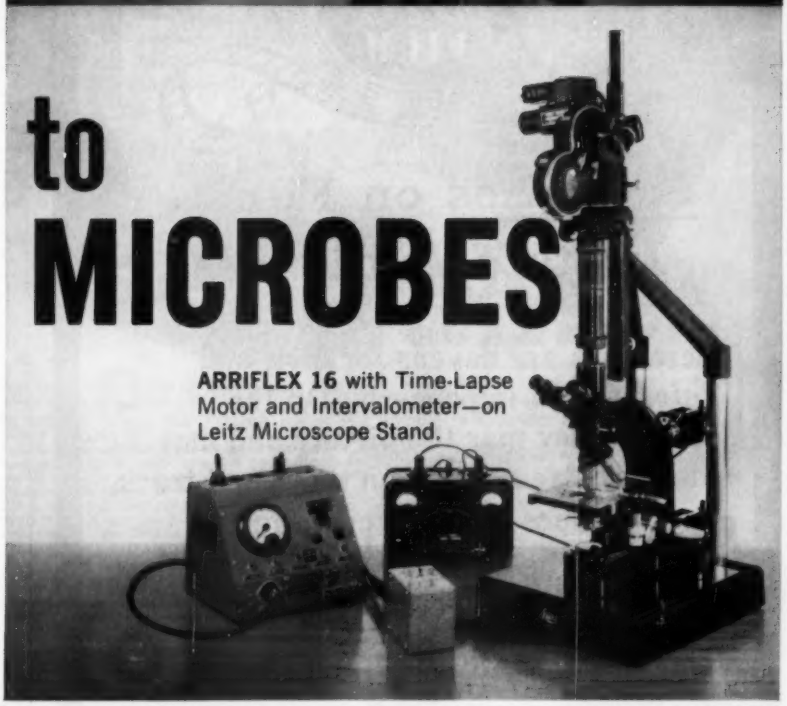

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It will also provide servicing and manufacturing facilities. Plans are underway for a second jointly-owned company to be formed in London, England, to provide sales and servicing facilities for Mitchell products in British and European markets.

Carbon Arc Projection is a 15-min sound picture in Technicolor which demonstrates the optics of motion-picture projection and the role of the carbon arc in the broad science of light, sight and color. A production of National Carbon Co., Division of Union Carbide Corp., the film is being made available for showing to exhibitor and projectionist groups. It cannot be shown at meetings to which an admission charge is made.

Opening of a Washington, D.C., office, at 1710 H St., N.W., has been announced by Hazeltine Corp., Little Neck 62, N.Y. The firm has major operations centered around defense activities including radar, both airborne and ground, electronic display, data processing, air traffic control, and missile guidance and launching.

A new film company, Allegro Film Productions, has been formed by Jerome G. Forman, news, sports and special projects film editor for Telenews and Hearst Metrotone News since 1947. He has also directed films. Operations will be geared to serve the needs of the individual film user. The new firm is located at 723 Seventh Ave., New York.

Allen B. Du Mont Laboratories, Inc., has been acquired by Fairchild Camera and Instrument Corp. in a recently announced merger action. Under the terms of the merger agreement, one share of Fairchild common will be exchanged for each 15 shares of Du Mont common and one share of Fairchild common for each 5.7 shares of Du Mont preferred.

A huge broadcasting center and a mobile tape recording cruiser are being constructed for Station WFAA-TV, Dallas, Tex., at an estimated cost of close to $2 million plus another $2 million invested in equipment. The studio building is scheduled to be completed early in 1961 and the cruiser is expected to be in operation in September. The cruiser, which is being constructed in California by Ampex Professional Products Co., will be equipped with two Ampex TV tape machines, six Marconi Mark IV 4½-in. image-orthicon cameras, General Communications transistorized video switcher and General Electric transistorized stereophonic audio facilities.

The 40-ft cruiser is planned as a complete studio on wheels, provided with its own power generators, special lighting equipment and engineering equipment for the handling of remote telecasts.

International Video Tape Recording and Production, Inc., 430 North Camden Drive, Beverly Hills, Calif., has announced the purchase of a 47-ft Videotape* Liner and equipment including two Ampex VR-1001A tape recorders, four Marconi Mark IV 4½-in. image-orthicon TV cameras, a custom-built video switching system and special effects generator. The Ampex machines are equipped with Inter-sync TV signal synchronizers. The firm will also operate a 40-ft amphibious cruiser for offshore location work. Cameras mounted on the cruiser will be linked by microwave or cable to the Videotape* Liner. It is planned to equip the Liner with a 50,000-w stabilized power generator.

Also announced was the formation of a company to be called Electronic Video Tape System, Inc., to handle such services as electronic editing, dubbing, duplicating, re-recording and altering of taped program material. (*TM Ampex Corp.)

A six-month test of in-store advertising by means of closed-circuit TV is being conducted by Store-Video, Inc., and the Grand Union Co. (supermarkets) of New York. The test, conducted in a supermarket, is to determine how much (and if) sales are affected by this form of advertising. The equipment, installed by Radio Corp. of America, consists of a camera, a number of monitors suspended just above eye level throughout the store and an automatic wheeldex device containing the product messages on telops.

Equipment for filming the Floyd Patterson-Ingemar Johansson world heavyweight championship fight was supplied by Camera Equipment Co., 315 W. 43 St., New York 36. The firm's president, Frank Zucker, acted as Director of Photography. Mannie Spiro was producer of the fight film for TelePrompTer. Seven cameras, plus two for standby, were used on the camera stand — five NCs equipped with telephoto lenses and four Mitchell High-Speed Cameras for slow-motion photography. Two cameramen and four Arriflex cameras were stationed at ringside. As one camera became empty the cameraman was handed a fresh camera, ready to go.

Scratches on Film Irritate Audiences

Scratches are havens for dirt, and refract light improperly. On the screen, they mar the picture and may distract attention. If on the sound track, they produce offensive crackling.

Fortunately scratches can almost always be removed — without loss of light, density, color quality, or sharpness. *Write for brochure*

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ALL-TRANSISTORIZED
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★ All-transistorized! Bulky batteries and heavy transformers eliminated.

★ Rechargeable battery or continuous A.C. operation.

★ 14 transistors for frequency response to 12,000 cycles.

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★ Equipped with transistor-matched FILMAGNETIC heads.

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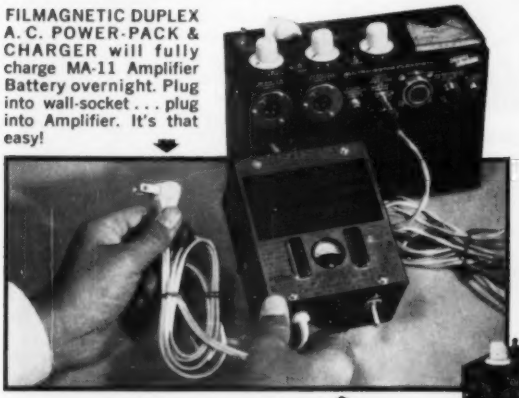
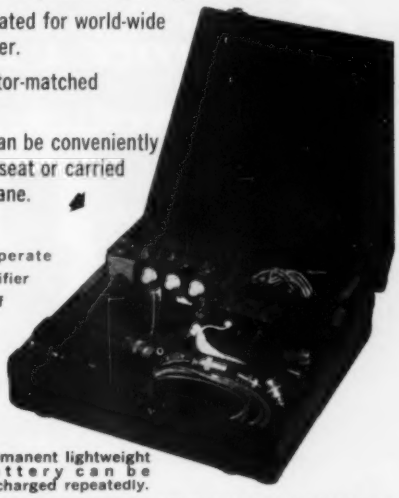
FILMAGNETIC DUPLEX A.C. POWER-PACK & CHARGER will fully charge MA-11 Amplifier Battery overnight. Plug into wall-socket . . . plug into Amplifier. It's that easy!



ALSO USED AS POWER-PACK for continuously operating Amplifier direct from 115 Volt A.C. current.



Fully charged Battery will operate Filmagnetic Model MA-11 Amplifier for more than 8 hours of sound-on-film recording.

Permanent lightweight Battery can be re-charged repeatedly.

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THIS IS THE FILMAGNETIC CAMERA UNIT for 16mm magnetic sound-on-film . . .

FILMAGNETIC sound-on-film recording can be factory installed on all existing, or earlier, Auricon Cameras. Recording on pre-stripe film, black-and-white **or color**, you get professional quality lip-sync talking pictures and brilliant music reproduction. After normal processing, the film can be shown on any 16mm magnetic-sound projector. In use since 1955, for exacting professional requirements, FILMAGNETIC, with the new MA-11 Amplifier, brings you the means for producing the finest in professional 16mm sound-on-film motion pictures. The **optical** sound-on-film capability of your Auricon Camera is not impaired. Change back and forth at will . . . without tools!

GUARANTEE

All Auricon Equipment is sold with a 30-day money back guarantee and a 1 year Service Warranty. You must be satisfied!

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BACH AURICON, Inc.

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THE BACH Auricon LINE OF 16MM SOUND-ON-FILM CAMERAS

CINE VOICE II
100 ft. Runs 2¾ min.

AURICON "PRO-600 SPECIAL"
400 ft. Runs 11 min.

AURICON PRO-600
600 ft. Runs 16½ min.

AURICON SUPER-1200
1200 ft. Runs 33 min.

AURICON . . . THE PROFESSIONAL CAMERA • STANDARD OF THE 16MM SOUND INDUSTRY SINCE 1931

A mobile medical color television unit manufactured by Marconi's Wireless Telegraph Co., Ltd., for Smith Kline and French Laboratories Ltd., is making a three-month demonstration tour of Australia, ending in October. An engineering team is provided by the Marconi Company to staff the vehicle. During the tour the unit will visit hospitals in Adelaide, Melbourne, Brisbane and Sydney to give color TV demonstrations. The 8-ton vehicle is divided into three sections, containing two tons of color TV apparatus.

Ampex Australia, Pty, Ltd., has been established as a subsidiary of Ampex International S.A. of Fribourg, Switzerland. Edmund J. Aleks is Managing Director of the new Australian company. He was formerly Western District Sales Manager for Ampex recording equipment in the United States.

A 10-volume set of Theatre Catalog is offered by Jay Emanuel Publications, Inc., 246 N. Clarion St., Philadelphia 7, at a considerably reduced price of $20. (Individual copies are priced at $3.00 and a set of any five copies at $12.50.) The 10-volume set contains 4680 pages and is illustrated with more than 10,000 views of theater buildings and with more than 1000 detailed drawings, floor plans and drive-in plans plus many other illustrations. A cumulative index contains thousands of references to items on theater design, construction, maintenance, management and equipment.

Plans for a new research laboratory in Japan to conduct fundamental studies in the physics and chemistry of solids have been announced by Radio Corp. of America. Martin C. Steele will be Director of Research of the new laboratory which will be called Laboratories RCA, Inc., Tokyo.

The Show Is on Video Tape is an illustrated booklet published by the Magnetic Products Division, Minnesota Mining and Manufacturing Co. describing the planning and production of three separate network commercials. First of a series to be called "Concepts in Video-Tape Recording," the booklet is priced at 25 cents and is available from Russell F. Roth, 3M Co., Box 3500, St. Paul, Minn.

Zero-Max stepless variable speed drives for fractional horsepower applications are listed and described in a 16-page illustrated catalog available without charge from Zero-Max Co., 1952 Lyndale Ave. South, Minneapolis, Minn. Details on all types of units, with or without motor, are given. Charts and diagrams are included.

Seven scientists were honored by the Society of Photographic Scientists and Engineers at an Annual Awards Luncheon held May 12, 1960, at the Miramar Hotel, Santa Monica, Calif. Douglas A. Spencer, Managing Director of the British subsidiary of Eastman Kodak Co., was named an Honorary Member, the highest recognition granted by the SPSE. Fellows of the SPSE cited at the Awards Luncheon were: Herman H. Duerr, Agfa-Ansco Corp. (Dr. Duerr was recipient in 1959 of the Herbert T. Kalmus Gold Medal Award bestowed by the SMPTE in recognition of his contributions to color photography); Ralph Evans, Eastman Kodak Co. (a recipient of the SMPTE Samuel Warner Award in 1949 and the Progress Medal in 1957); R. Clark Jones, Polaroid Corp.; and C. B. Neblette, Rochester Institute of Technology, Rochester, N.Y. Newly elected Senior Members are Peter Krause, Agfa-Ansco Corp.; and Carl R. Markwith, U.S. Operations Mission, Tehran, Iran.

Thirty-nine nontheatrical films selected by the Committee on International Nontheatrical Events (CINE) were shown at the Venice International Exhibition of the Film on the Arts, June 15–17, and will be shown during the year at three other film festivals — in Berlin, Vancouver and Edinburgh. The films are divided into special categories such as documentary and short films, science and didactic films, children's films and art and experimental films. CINE Chairman is Ralph L. Hoy. Vice-Chairmen are James A. Barker and Stanley McIntosh. Coordinator is Anna L. Hyer. Offices are at 1201 16th St. N.W., Washington 6, D.C.

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Complete with optical sound reproduction head (or choice of magnetic sound) base plate, amplifier-speaker. For single or double sound. Easy to handle, no twisting films. An unbeatable combination with the Zeiss Moviscop 16mm precision viewer, sharp brilliant 2¼ x 3¼ picture.

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Zeiss Moviscop Viewer.... 89.50
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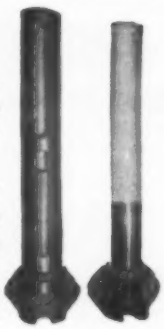

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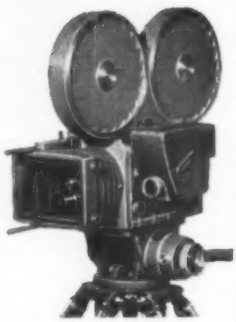
Auricon Pro - 600 and Super 1200. Single system 16mm sound on film cameras. Latest model Cine-Voice 11 sound cameras. TV kinescope shutters, new and used in stock.



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Page Communications Engineers, Inc., has moved from 710 14th St., N.W., Washington, D.C., to a four-story brick building at 2001 Wisconsin Ave., N.W. The new building, called Page Communications Building, is designed to house the offices and the laboratories, formerly located in Maryland.

Thirteen new sheets have been issued by Sylvania Electric Products, Inc. to be substituted for corresponding sheets in the Projection Lamp section of the *Sylvania Photolamp Technical Manual*, thus bringing the information up to date. One sheet, No. 7534, is to be removed as the lamp type it describes, No. 750T12TF, is no longer included in the Sylvania product line. Other lamps have been changed in such respects as light source dimensions, filament type, etc.

Wells R. Chapin has been appointed Manager of Marketing for Dage Television Division, Thompson Ramo Wooldridge, Inc. He was formerly Northeastern Regional Sales Manager for General Electric Co. In his new post he is responsible for the Division's expanding marketing activities.

Walter A. Steiner has been appointed Vice-President in charge of technology for National Carbon Company, Division of Union Carbide Corp. He has been Vice-President in charge of development. In his new post he will be in charge of research as well as development activities. He has been with the company since 1924.

Emerson Yorke, independent film and TV producer, will shortly release a half-hour TV Sports Special entitled *This Is Baseball*. Filmed in 35mm black-and-white, plays at key positions are highlighted by camera speeds ranging from normal through to various degrees of slow motion. Technical credits include Burgi Contner ASC and Russell Carrier on camera; Joseph Dervin ACE, supervising editor; Joseph Johnson, script; Glen Glenn, sound recording; Solita Palmer ASCAP, original music score.

Robert Sackman has been elected Executive Vice-President and Chief Operating Officer of Ampex Corp., and Phillip L. Gundy and Thomas L. Taggart have been named Senior Vice-Presidents. Other personnel items include the appointment of Gerald F. Rester as Eastern Sales Manager and Frank Gonzales, Jr., as Southwestern Regional Sales Manager for the Video Products Division of Ampex Professional Products Co.

F. D. Meadows has been appointed Manager, Video Product Administration, Ampex Professional Products Co., a division of Ampex Corp. The post involves administrative control of all video products manufactured and distributed by Ampex, including its video-tape recorder, the Marconi Mark IV TV camera and associated video products and services. Prior to his present appointment he was Commercial Manager of the Broadcast Equipment Division.

Thomas C. Clark has been appointed a Vice-President of Houston Fearless Corp. Formerly Assistant Vice-President and General Manager of the company's Los Angeles Division, he will continue in the latter position. He has been with Houston Fearless since September 1959 and prior to that was Marketing Director of the Communications Division of Hughes Aircraft Co.

Six new appointments, four of which are in the Engineering Department have been announced by Audio Devices, Inc., 444 Madison Ave., New York 22, as part of an expansion program at the firm's Stamford, Conn., plant. James R. Ramsey has been appointed Quality Control Manager and George W. Fouser is the new Quality Control Supervisor. Additions to the Engineering Department are Edward O. Mueller, John E. Jackson, Per Arne Fladager and Peter R. Rohner.

The Handling, Repair, and Storage of 16mm Films is an Eastman Kodak publication, Kodak Pamphlet No. D-23, which has been extensively revised from an earlier publication. It is of special interest to industrial photographers and advanced amateurs. The 11-page pamphlet discusses causes of damage to 16mm film, means of promoting long film life, cleaning, lubricating, splicing and storage. It is available without charge from Sales Service Division, Eastman Kodak Co., Rochester 4, N.Y.

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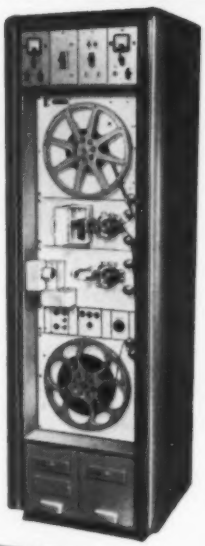
SOUND SYSTEMS

—the highest standard in sound recording and reproducing

GAUMONT-KALEE equipment is designed in accordance with accepted current practice in the Industry, and is fully compatible with other approved sound systems.

Gaumont-Kalee Rack Mounted Optical and Magnetic Reproducer—35 mm. and 16 mm. types available; also rack mounted and portable magnetic recorders.



The new Gaumont-Kalee All-metal Four Channel Mixer Console.

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Cables: BENBERG, LOSANGELES, Tel: HOllywood 2-0871

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Why do filmmakers prefer to deal with Florman & Babb? In our technical field, the only answer is SERVICE . . . and service is PEOPLE. Here is just one of the many skilled technicians at Florman & Babb whose experience and know-how are always available to solve *your* problems.

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Biographical Notes

Merle L. Dundon

Merle L. Dundon retired June 1 from the post of Assistant Manager of the Film Emulsion and Plate Manufacturing Division, Kodak Park Works, Eastman Kodak Co., Rochester, N. Y. An internationally known authority on color photography, Dr. Dundon was the recipient in 1958 of the Herbert T. Kalmus Gold Medal for contributions to the design and development of color products (*Journal*, p. 844, Dec. 1958). Among many other honors awarded him during a 37-year career with Eastman Kodak are the Bronze Medal of the Société Française de Photographie (presented jointly to Dr. Dundon and J. I. Crabtree in 1926 for outstanding research work) and the honorary degree of Doctor of Science bestowed in 1943 by Mt. Union College (where he had completed his undergraduate work in 1917).

During World War I he was stationed at the American University Experiment Station of the Chemical Warfare Service. Subsequently he attended Ohio State University where he was granted the degree of Master of Science in 1920, and the degree of Doctor of Philosophy in 1922. In 1923, following a year of research at the University under a National Research Fellowship, he joined Kodak Research Laboratories, where he specialized in photographic chemistry, and for several years worked on problems connected with the Cine-Kodak Reversal Process. In 1929 he was transferred to the Film Emulsion Department.

Dr. Dundon co-authored (with J. I. Crabtree) several outstanding papers in the *SMPE Transactions*, on cause of fog in photographic developers, use of desensitizing dyes, and on new color materials. In 1930 he published in the (then) newly named *SMPE Journal* a paper describing a quick test for determining the degree of exhaustion of developers, co-authored with G. H. Brown and J. G. Capstaff.

Professional organizations of which he is a member include American Chemical Society, American Association for the Advancement of Science, and the Society of Photographic Scientists and Engineers. He is a Fellow of the Photographic Society of America.

Emery Huse

Emery Huse retired June 30 after more than 40 years with Eastman Kodak and more than 30 years service as Manager of the West Coast Division of the Motion Picture Film Dept. He is succeeded by Norwood L. Simmons, who has been Assistant Manager of the Division.

A Past-President of the Society (he was President in 1941–42), he is a recognized authority on film processing procedures. He came to Hollywood from Rochester, N.Y., in 1928, about the time that sound was revolutionizing the motion-picture industry. Problems of all kinds followed the advent of the "talkies," among them problems of processing and control. In working toward the solution of these problems, Mr. Huse also contributed toward the introduction of continuous film processing procedures. During the following decade he was concerned mainly with the study of black-and-white film duplicating methods resulting in the establishment of more precise criteria which led to the development of improved duplicating film. He also initiated methods for the chemical analysis of film processing solutions. The acceptance of Eastman Color Films, introduced about 1950, was greatly facilitated by the technical service directed by Mr. Huse.

Author of numerous articles on technical subjects, he became Technical Editor of the *American Cinematographer* in 1930.

He is the author of several papers published in the *Journal* and is co-author with Dr. Simmons of a paper on "Current Black-and-White Duplicating Techniques Used in Hollywood," published in the October 1947 issue of the *Journal* (pp. 316–333)

He is also a member of the Academy of Motion Picture Arts and Sciences, Photographic Society of America, Optical Society of America, American Chemical Society, and is an associate member of the American Society of Cinematographers.

His successor, Dr. Simmons, is now SMPTE President. He has been with Eastman Kodak since 1937 and has been with the West Coast Division since 1941. He became Chief Engineer of the Division in 1954 and Assistant Manager in 1957.

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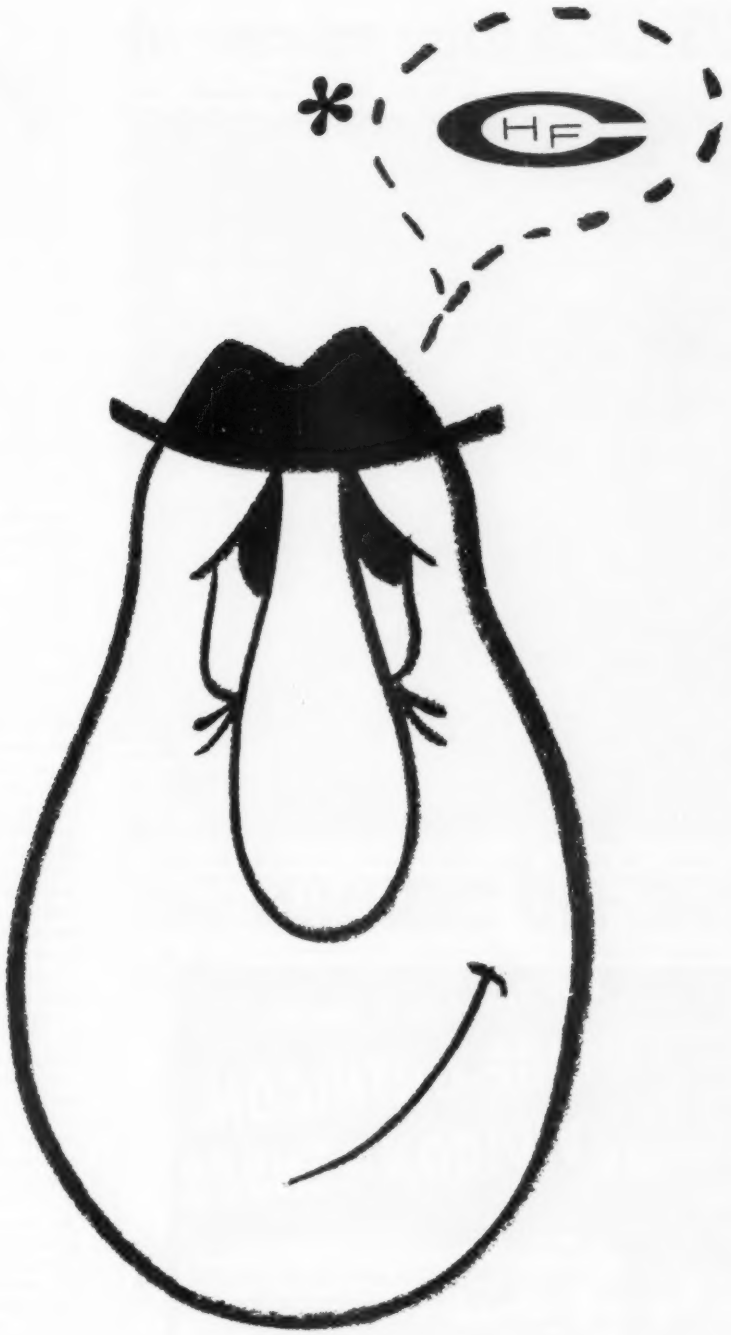

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Obituary

Edward W. Kellogg

Edward Washburn Kellogg died May 29, 1960, at the age of 78. He retired as a research and development engineer at the Radio Corp. of America in 1948, but continued active as a consultant at his home in Haddonfield, N.J. He was an Honorary Member of the Society.

A man of great ability, energy, inventiveness and enthusiasm, he was active in the Society for many years and made many important contributions to its progress. He authored many technical papers, more than 20 of which were published in the Society's *Journal*. His work was recognized by the Society by presentation of the Journal Award for the best technical paper published in 1935, "A Comparison of Variable-Density and Variable-Width Systems," and the 1937 Progress Medal Award for his work in sound reproduction. His most recent paper, "A History of Sound Motion Pictures," was published in three parts, in the 1955 June, July and August issues of the *Journal*.

Born at Vineland, N.J., he received his education at Phillips Andover Academy, Princeton University (where he was elected to Phi Beta Kappa), and Cornell University. He taught for a time at the University of Missouri, and later at Texas A&M, and Ohio University. Although he was trained in civil engineering, his opportunities and interests led him into other technical fields where he did his major work in the areas of electro-acoustics, mechanical and electrical engineering, photography and optics, to the end of greatly improving sound reproduction in the radio, phonograph, and motion-picture industries.

After joining the General Electric Company's research staff in Schenectady in 1917, where he first worked on submarine detection during World War I, he became co-inventor with Chester W. Rice in 1925, of the dynamic cone loudspeaker which has since remained the basic sound reproducer of modern audio communications and entertainment. The electrical phonograph pickup developed by him the following year was also a basic and enduring improvement that prepared the way for better quality in this industry. With the coming of the sound motion-picture art in 1927, Mr. Kellogg was concerned from its beginning with every aspect of the problem of providing high-quality sound in return for the loyalty of the public expressed at the boxoffice. This included work on sound recorder and reproducer mechanisms, theater speakers, recording and reproducing optical systems, sound printers, and on the many photographic problems peculiar to the sound film. His effort and originality are attested by the grant of 107 patents on work he did at the General Electric Company, and at the Radio Corporation of America which he joined in 1930, and which bestowed on him the RCA Award of Merit in 1947.

He was a charter member of the Acoustical Society of America and the American Physical Society, and of the American Society of Inventors. In 1949 he received the "Modern Pioneer Award" of the National Association of Manufacturers.

Mr. Kellogg was a faithful member of Trinity Episcopal Church in Moorestown, N.J., and since his retirement had authored an article entitled, "An Engineer Looks at God's Handiwork," which has been broadcast at various times by station WFLN (FM) in Philadelphia.

Throughout his long and fruitful career Mr. Kellogg was driven by a real passion for improvement in the quality of recorded and reproduced sound, and freely lent his genius and his encouragement to the making of advancement whenever and by whatever means it might appear possible. For example, in his study of the fundamental character of waveforms of certain sounds in speech, he taught himself to speak phonetically backwards. He verified his accomplishment (to the amazement of his colleagues) by an entirely intelligible reverse playback of his recording. His career brought him many interesting experiences and gave much inspiration to the people who had the good fortune to work with him. Although he was serious and always sincere his wit and humour often proved a surprising ingredient in the solution of problems with which he became associated.

Among his most interesting experiences was the construction of apparatus for the successful reproduction of a sound record that had been made on a glass plate by Alexander Graham Bell. Bell's methods of making the record had been primitive but ingenious, but neither he nor anyone else had ever heard the result of his work. At that time, photoelectric cells and vacuum tube amplifiers did not exist and they were indispensable to reproducing the record. Mr. Kellogg and his associates succeeded in understanding almost the entire message that Bell had recorded, although the quality of the sound was extremely poor.

As an example of his wit and humour, Mr. Kellogg was once faced with an awkward question at a Society Meeting when he was asked why a new magnetic film-motion stabilizer which he had developed and was vigorously advocating was so much better than the oil-damped stabilizer that his company had been enthusiastically promoting. The answer to the question, he said, was that when the magnetic flux leaked out of the new stabilizer it did not have to be wiped up with a rag. After this remark had been fully savored by the meeting its regular business proceeded without further delay.

Mr. Kellogg will be deeply missed by his close associates and his many acquaintances, but his influence continues on, and many enduring memories remain in compensation for his loss.

(*Edit. Note:* This obituary was graciously contributed to the *Journal* by associates of Mr. Kellogg.)

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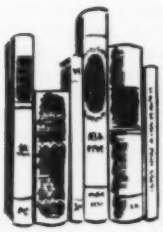

books reviewed

Kino

By Jay Leyda. Published (1960) by Macmillan Co., 60 Fifth Ave., New York 11. 494 pp. incl. appendixes, list of sources, index + 32 pp. of plates. Other illus. 6 by 9-in. Price $9.50.

This ambitious and meticulously documented work traces the development of the Russian film from 1896 (when the first Russian Film Theater was opened at 46 Nevsky Prospect) to 1948. The author explains in the Introduction, "A consciousness of a common historical hazard (the too-recent past) has prevailed to end my narrative proper with the death of Sergei Eisenstein in 1948. The ten years since then are treated, more generally, in the form of a postscript." Closely packed with enlightening comments and bits of information, this work is worthy of careful attention on the part of the reader. Although replete with firsthand stories of film personalities, quotations from diaries, documents, letters and conversations recorded or recalled by the author, the book is in no sense a patchwork of anecdotes. Rather, the author has used this method to develop his main theme of the continuity of Russian filmic art from its beginnings to the present, and its development artistically and technically. One of the author's contributions (perhaps the first of this kind) is his examination of the Russian Revolution (Chapters V, VI and VII) in terms of its effect on the motion-picture industry.

The author brilliantly develops the theme that the future of cinematography in the Soviet Union is linked to its past and that there is a clearly discernible line of development.

Illuminating comments and bits of historical information should not be overlooked by the careful reader. For example, Chapter V (from February to October) gives an interesting sidelight on the climate of the times: "The February Revolution was joyfully greeted by the film workers. Nevertheless, in the confusion everyone forgot to film anything on the first days — February 26 to 28. Not until March 1 did the cinematographers collect their wits and take their cameras out into the streets."

Another interesting account is that of the association of the "tall Swede named Edward Tisse" with the great Eisenstein. Tisse began his career as a newsreel cameraman and by a fortunate meeting began a life-long association of great importance to the artistic development of both men. The author says that "Many of the accomplishments in *Potemkin* (usually re-

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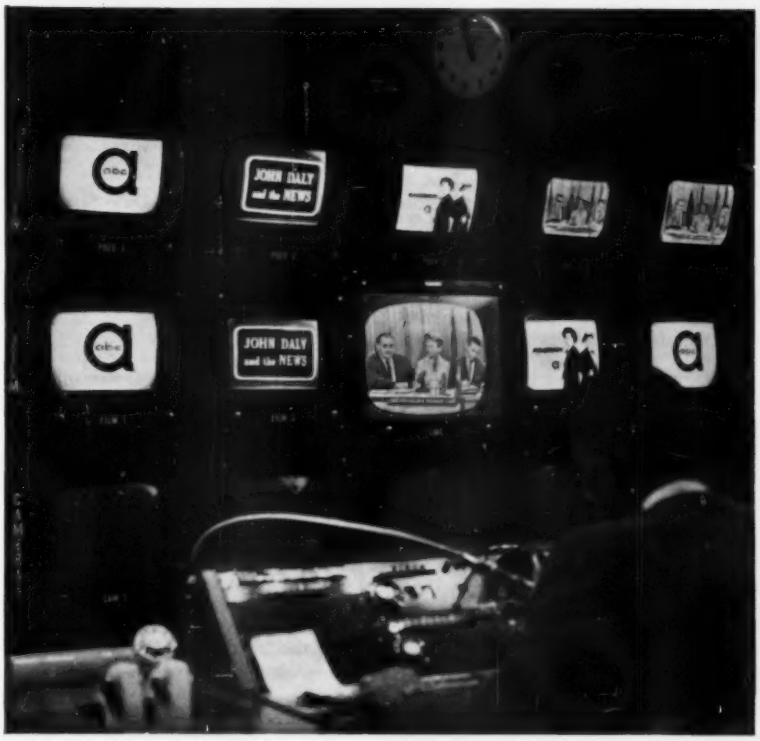

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garded as Eisenstein's masterpiece) can be ascribed to the understanding with which Eisenstein and Tisse worked together."

All in all, *Kino* can be described as a fascinating book well worth the time of anyone whose cultural interests include the art of the motion-picture.

From Microphone to Ear (2nd ed.)

By G. Slot. Published (1959) by Macmillan Co., 60 Fifth Ave., New York 11. (1st ed. published 1956 by N.V. Philips Gloeilampenfabrieken, Eindhoven, Holland — translated by E. Harker, Mitcham-Junction, England). 258 pp. incl. index and appendix. Illus., graphs. 8 by 5½-in. Price $4.50.

The book discusses all phases of sound recording and reproduction in simple, nontechnical language. Intended as much for music lovers and "gramophone" owners as for sound technicians, the author ranges from the history of the reproduction of sound through the scientific principles involved and includes helpful hints on how to care for records and needles. The second edition has been revised and enlarged to include discussions of stereophony and other recent technical developments and a chapter on stereophony has been added which discusses directional hearing, the stereophonic record, amplifiers, loudspeakers, and stereo and monophonic records. The author, in the Foreword, states that the intent of the book is "to answer as many as possible of the questions posed by gramophone owners (so as) to be understood by readers without technical training . . . ." The "gramophone owner" envisaged by the author apparently has considerably more interest than the average owner in understanding all the technical details of each step of sound recording and reproduction and a more than ordinary desire to become aware of the possibilities and limitations of tape and disc.

Moon Base

By T. C. Helvey. Published (1960) by John F. Rider Publisher, Inc. 116 W. 14 St., New York 11. 72 pp. incl. glossary. Illus. Paperbound. 5½ by 8½-in. Price $1.95.

The American flag will first be raised on Lunar ground by three people — two men and one woman, making up a team of specially trained space scientists, that is if plans now underway and sketchily outlined in this impressive little volume are completed on schedule.

Neatly skirting the sociological and moralistic implications of such an arrangement, the author reports on discussions of the technical and psychological considerations involved. (The author is Principal Biophysicist of the Research Division of Radiation, Inc., Orlando, Fla.)

Perhaps the most astonishing thing about this book is that it is so matter-of-fact. No more than five years ago it might have been considered for publication in one of the more "way-out" science fiction publications. Its flat, declarative style makes it all seem so appallingly real. The book discusses such matters as radiation shielding ("A certain amount . . . may be necessary on the moon surface for tolerable long-term lunar mission . . . the protective suit is made of glass fiber of the lead silicate type . . . The suit weighs about 150 lb on earth — 25 lb on the moon"); a plastic lunar shell; crew equipment for the lunar surface; design of routine task program; equipment for the maintenance of the crew's physical and mental health ("Provison for bathing facilities or other means for personal cleanliness is an unsolved problem"), and other practical considerations. Communication devices will probably include a video circuit over the earth-moon r-f link.

The book is easy to read and is recommended for a brief glimpse of the work-a-day world of the near future. It is enhanced by apt and witty illustrations.

Symposium on Radiation Effects on Materials, Vol. III

Sponsored jointly by the American Society for Testing Materials and the Atomic Industry Forum. Published (1959) by American Society for Testing Materials, 1916 Race St., Philadelphia 3. 164 pp. Illus., graphs, tables. 9 by 6-in. Price $4.25.

Twelve papers, presented at a Symposium held in Boston in June, 1958, are published in this volume. The papers are grouped in three categories: Dosimetry Considerations; Irradiation Facilities and Techniques; and Studies on Radiation Effects. A particularly interesting paper was presented by John L. Colp and H. N. Woodall on "Effects of High Neutron and Gamma Fluxes on Transmission Characteristics of Some Optical Glasses." Specimens of several types of optical glasses used in this study were supplied by Bausch & Lomb Optical Co. Most of these glasses are of the radiation-tolerant, or "Protected," type developed by the firm under AEC contract. The research was undertaken for the Sandia Engineering Reactor Facility with the aim of determining the feasibility of viewing a 5-mw reactor, during operation, through a periscope. The research indicated that "protected" optical glasses could be safely used for the proposed periscope.

Television Crime-Drama:

Its Impact on Children and Adolescents

By R. J. Thomson. Published (1959) by F. W. Cheshire, Melbourne, Australia, for the Department of Audio-Visual Aids, University of Melbourne. 5½ by 8½ in. 197 pp. incl. appendexes and bibliography. Price 25 shillings (about $3.50).

A series of experiments is being conducted by the Department of Audio-Visual Aids of Melbourne University to determine the psychological effects of various types of television programs on children and adolescents. The first published report was on the effects of the "Western" program (*Journal*,

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p. 794, Nov. 1958). This second book in the series examines the effects of crime-dramas on selected groups of high-school and grade-school pupils.

The plots of three of the dramas viewed by the children centered around (1) the murder of a young girl by a sex-maniac; (2) the murder of a young man by his mistress, he having been hypnotized by the psychoanalyst husband, and the subsequent murder of the husband by the erring wife ("Rita seems stunned as she watches her husband's death throes" — quotation from the script); and (3) a woman killed in a particularly horrifying street accident (her head is bashed in by a swinging crane as she waves to her child who is on the way to school) is projected twenty years into the future in the instant before her death. There she "lives" through a particularly miserable day before the camera returns to the "close-up of the onrushing steel mass to Mrs. Clarke's face transfixed with horror." It is interesting to note that TV programs of this type would, in the United States, be described as "horror movies" rather than "crime dramas." These, in the United States, usually follow the familiar "cops and robbers" pattern where the action revolves around the discovery, chase and capture of the criminal.

In making these studies, ultraviolet photographs were taken of the audience during the viewing and later examined to determine and classify changes of facial expression as the plot developed. The children were also given a written "film quiz" on their reactions to the various programs, and other tests were given. Among the main findings as set forth in a summary: "On the whole, the television and film frequenters of crime drama programs did not exhibit as high a degree of emotional responsiveness . . . . as children matched with them for similarity of personality, etc. . . . . There is possible evidence here of some sort of natural safeguard operating to protect the typical crime-drama audience from stress effects . . . . There was no evidence that viewing a crime drama provoked any criminal or psychopathic tendencies in the great majority of viewers."

As a further check some groups were recalled for viewing sessions during which motion-picture films were made in complete darkness using infrared emulsions. The investigators were thus enabled to watch the audience throughout a complete sequence rather than at one selected point and thus have a record of the viewer going from a calm state to one of tension and vice versa.

Film-Making on a Low Budget, No. 29 in a series of Reports and Papers on Mass Communication, published by the United Nations Educational, Scientific and Cultural Organization, Place de Fontenoy, Paris 7, is a report on a pilot project launched by Unesco and the United Nations Relief and Works Administration to determine the possibility of establishing a self-contained film production unit with a small outlay of capital and to study the potentialities of newsreel production on a small scale. Authors of the report are Myrtle Winter, Chief, Visual Aid and Photographic Division, UNRWA; and Norman F. Spurr, Unesco Visual Aids

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Specialist. A report on work-in-progress on the pilot project was contributed to the *Journal* by Mr. Spurr and published in the August 1957 issue (pp. 470–472).

In the Unesco report, Miss Winter discusses the aims and achievements of the project and Mr. Spurr describes in detail the technical aspects.

To Pay Or Not To Pay: *A Report on Subscription Television* by Robert W. Horton (published (1960) by the Center for the Study of Democratic Institutions, Box 4068, Santa Barbara, Calif. 12 pp. 8½ by 11-in.; single copies available upon request.)

The author presents a thoughtful analysis of the Pay-TV controversy. "The outcome of the Pay-TV controversy," he states, "will have a direct influence upon our constitutional right of free expression, our right to hear all sides of an issue; specifically, it will affect our educational, political, economic and general cultural activities." Topics discussed include The History of Pay-TV Proposals; The Opposition; The Proponents; The Costs of Pay-TV; The Five Pay-TV Systems; The Rights of the Public, and The Responsibilities of the Industry. In his discussion of the five main systems, the author notes "If this multiplicity of systems actually went into operation, there could be electronic chaos. The FCC has done nothing to prevent this potential confusion."

A Primer on Television Tape Recording by George B. Goodall (48 pp.) describes in nontechnical language the basic principles of video-tape recording. Illustrations and diagrams accompany descriptions of components and equipment. The book is written in clear and simple language; it should be easily understood by the interested laymen and of interest to the engineer. It is published by Robins Industries Corp., Flushing 54, N.Y. It is priced at $1.00.

Electronic Engineer's Reference Book

Ed. by L. E. C. Hughes. Published (1958) Macmillan Co., 60 Fifth Ave., New York 11. 1312 pp. incl. numerous tables, diagrams, list of abbreviations. 5 by 7-in. Price $18.00.

This British handbook on electronic engineering makes a valiant effort to serve in part as textbook on electronics as well, by including considerable general explanatory text material, and also by covering briefly many fringe arts. Among the latter are radio astronomy, nuclear chemistry, photocopying, computers, automation, engineering education and patent procedures. However in order to keep the book manageable there are excluded radar, radio and television (some radio propagation and a little on color television are retained), telecommunications, wave-filters, and all military equipment. Since these essentially are the arts that really developed electronics, they are significant omissions.

Some fifty specialists have compiled the work, which is formally grouped under Fundamentals, Radiations, Electrics, Valves (electron tubes), Materials, Vibra-

tions, Computers, Automatics, and Miscellaneous.

Under "Valves," among other things, 32 pages are devoted to a systematic discussion on the design of pentodes. There is a listing of the major characteristics of some 500 to 600 types of British-made electron tubes, and of over 140 bases. However, it is interesting to note that there is not a word about interchangeability problems or possibilities with U.S. tubes.

The British seem to love our "alphabet soup" designations — but theirs are mostly unpronounceable. There is an abbreviations list of over 1500 of them, which still misses some used in the text (whatever is SRBP on page 1159?). There is a short table of equivalent nomenclatures in the U.S. and U.K. This has some suspect terms ascribed to Americans, such as "analagy" and "analagous" for the English "analogy" and "analogous," and "hix" for "picture" (probably a misprint for "pix").

It is interesting that the handbook carries advertising pages scattered amongst the text — to the extent of some five per cent. The paper used throughout is fairly heavy and durable — the 1312 pages take 2½ inches of thickness (covers additional).

For the motion-picture and television engineer the principal interest of the book will be in its extensive general sections, and those on such topics as materials, acoustics, music and photoelectrics, or again in consultations needed on British-made equipment.—*Pierre Mertz*, 66 Leamington St., Lido Beach, L. I., N.Y.

Handbook of Electronic Tables and Formulas

Compiled and edited by Donald Herrington and Stanley Meacham. Published (1959) by Howard W. Sams & Company, Inc. The Bobbs-Merrill Company, Inc., 2201 East 46 St., Indianapolis 6. 128 pp. incl. Table of Contents, List of Tables. Illus., numerous charts, graphs. 5½ by 8½-in. Price $2.95.

The information in this handbook is divided into five major classifications as follows: (1) Formulas and Laws of Electronics; (2) Constants, Standards, Symbols, and Codes; (3) Service and Installation Data; (4) Mathematical Tables and Formulas; (5) Miscellaneous. Included are such items as Formulas for Resistance, Capacitance and Inductance in (1), Electronic Symbols and TV Channel Frequencies in (2), Coaxial Cable Characteristics and Miniature Lamp Data in (3), Decimal Equivalents of Fractions and Trigonometric Functions in (4), and Characteristics of the Elements and Metric Equivalents in (5). Eight nomographs and twenty-two tables help materially in presenting this information in a concise form. The usual reactance charts, frequency-wavelength conversion, logarithmic tables, the Greek alphabet and so on are in this category. Emphasis has been placed to quite an extent on the practical usefulness of the contents, exemplified by including such items as the standard color code for resistors and capacitors.

An effort has evidently been made to present information with the utmost clarity and simplicity. In this respect the book succeeds to a considerable extent. It is anticipated that even those whose technical training is relatively limited will find most of the material in the book quite understandable. Those who have a more academic background will probably miss some of the data usually found in larger handbooks such as derivatives, integrals, natural logarithms, radio propagation data, and so on.

The choice of material included in this book was undoubtedly made very carefully and judiciously with the purpose in mind of satisfying the basic needs of a large number of service engineers, technicians, amateurs, and non-specialists in the electronic field. Since it is a relatively thin volume it is not overburdened with a wealth of information that might be useful to only a limited number of people. Criticisms can easily be made regarding both the selection of material included and the material omitted. For instance, such important new fields as semiconductors and computers receive relatively scant treatment. On the other hand, the relatively lengthy description of the methods used in calculating with logarithms will be considered by some to be superfluous. On the whole the choices made seem to be quite satisfactory for the members of the electronic fraternity that this book is evidently intended to reach.

What is somewhat disturbing about this volume, though perhaps understandable in a first edition, is the number of errors that were discovered without attempting to proofread the entire text thoroughly. The formulas at the top of page 19 are evidently transposed, exponents are missing in several equations on pages 29 and 30, one of the figures in Table I is in error, the formula for attenuation on page 38 is obviously wrong, all these items contribute to an uneasy feeling that there may be still other undiscovered misprints. The index was also found inadequate in several respects.

In a future edition it would be desirable, of course, to eliminate these errors and to improve the text in perhaps several other respects. Instead of the Indian Head Test Pattern, the EIA Standard Resolution Chart also approved by the IRE would appear to be a better choice. Also since the Standard Color TV Signal Waveforms are presently included in this volume, consideration should be given to the inclusion of the Standard Monochrome Signal Waveform also.

Many other suggestions for changes, additions, and improvements will undoubtedly be received by the publishers which should eventually result in a second edition more accurate and useful than this first volume.—*W. J. Poch*, 3 Haines Dr., Moorestown, N.J.

Keemag Graphic Solutions in the Use of Lenses

By Joseph D. Brubaker. Published (1958) by Joseph D. Brubaker, 949 Sherman Ave., Evanston, Ill. 50 pp. incl. two calculator dials, charts, graphs, etc., 8½ by 11-in. loose-leaf cardboard cover. Price $15.00.

WE DESIGN & BUILD
CUSTOM
CAMERAS
Whatever your photographic recording problem, CAMERAFLEX designs and builds to your special needs, or adapts current CAMERAFLEX models to do your job.
Among our clients:
BENDIX · RCA · PHILCO · U.S.A.F.
NBC · OPERATION DEEPFREEZE
CAMERAFLEX
Division of Federal Mfg. & Eng. Corp.
1055 Stewart Avenue
Garden City, Long Island, N.Y.

This is a collection, in a loose-leaf binding, of a series of diagrams, graphs and tables pertaining to a number of elementary optical relationships. The information will probably be of great value to the practical photographer. It is presented in a ready-reference form to enable him to determine quickly the required lens and camera settings for a variety of magnification ratios, as well as corresponding field sizes, exposure corrections for lens extensions, and depths of field. Two computers of the rotating dial type are included, one for determining exposure corrections corresponding to various magnifications, and the other showing the relationship between the per cent of reduction or enlargement of original subjects and the corresponding dimensions of the reproductions.—*Allan L. Sorem*, Research Laboratories, Eastman Kodak Co., Rochester 4, N.Y.

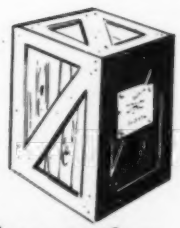
The Science of Photography

By H. Baines. Published (1958) by Fountain Press 46/47 Chancery Lane, London W.C. 2; distributed in U.S.A. by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 320 pp. incl. index. Profusely illus. 8½ by 5½-in. Price $7.50.

The Foreword by Percy W. Harris describes *The Science of Photography* as "a treatment of photography from the scientific viewpoint without any attempt to dodge the difficult parts and yet couched in language which the ordinary photographer can understand." The book admirably conforms to this description. Pellucid prose and a sound scientific approach are all too seldom combined in the same treatise, so a perusal of this work is a delight not only to the photographer but to the less tutored reader as well.

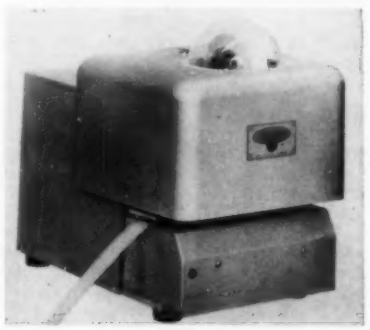
The book does not contain a bibliography, but careful, scholarly research is evident on every page. As a random example, the first chapter (How Photography Began) contains such little gems of information as, "Silver nitrate was known to Albertus Magnus before 1280. . ." and then goes on to give — with rare economy and clarity — a survey of the history of photography. The book's 25 chapters range over chemistry, developers, sensitometry, reciprocity failure and other photographic effects, granular structure, color photography and other subjects having to do with the science of photography as distinguished from photography as an art.

They See What You Mean: Visual Communication With the Overhead Projector is published by the Audio-Visual Department of Ozalid Division, General Aniline and Film Corp., Johnson City, N.Y. The 88-page book is divided into sections dealing with (1) Visual Communication and the Overhead Projector; (2) Handmade Transparencies; (3) The Diazo Process; (4) Transferon; (5) Transparency Mounting Techniques; and (6) Transparency Design. The book contains a bibliography and a list of Ozalid products referred to in the text. It is profusely illustrated.



new products (and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.



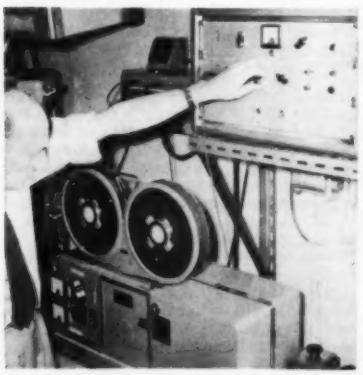
The Unicorn Automatic Film Splicer for darkroom splicing operations has been announced by Computer Measurements Co., 12970 Bradley Ave., Sylmar, Calif. The splicer is designed to be used safely in total darkness with the automatic splicing operation completed in six seconds. In operation, the two film ends are placed in positioning grooves and clamped in place and a button is pushed to complete the splice. The manufacturer recommends the use of pressure-sensitive Mylar tape (a product of E. I. du Pont de Nemours) for unbreakable splices. The splicing tape is rolled completely around the trimmed edges of the film and the corners and edges are sealed to permit free passage through processing machines, precision sqeegees, applicators and slitters. Dimensions are 12 by 15 by 11-in.; weight is 47 lb; power requirements are 115-v, 60-cycle a-c. Three standard models are available for 16mm, 35mm and 70mm film. Splicers for other film widths are available on special order. Price of the 16mm and 35mm models is $2200. The 70mm model is priced at $2700.

The Auxiliary Target Finder for Arriflex cameras has been announced by Arriflex Corp. of America, 257 Park Ave.

South, New York 10. Designed for use with long focal length lenses, the Target Finder compensates for the extremely small field of view by enabling the photographer to "find" small fast moving objects quickly and easily. The Albada optics of the finder are mounted and aligned as shown in the illustration. The design of the instrument is to enable the cameraman to see a bright clear reticle projected in space out over a wide field. The center dot of the reticle is superimposed on the target. When the instrument has been aligned, centering the target in the reticle of the target finder automatically centers the object in the frame of the camera. Three models of the finder have been constructed for use with late and early models of the Arriflex 16 and the Arriflex 35. The finder is priced at $80.

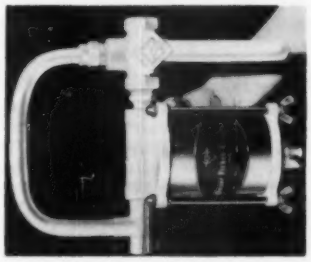
Availability of two lenses manufactured especially for Arriflex cameras has been announced by Arriflex Corp. of America, 257 Park Ave. South, New York 10. The Angenieux 140 Varifocal lens has a focal range from 35mm to 140mm and a maximum aperture of *f*/3.5. It focuses down to 5 ft. It is manufactured by Angenieux in Arriflex mounts. Designed to cover the 35mm motion-picture frame, it may be used on both Arri-16 and Arri-35. It is priced at $1395.

The Pan Cinor, model 85, lens for the Arriflex 16 is available in limited quantities. The focal range is 17.5mm to 85mm, aperture *f*/2. The "zoom" movement is lever operated. It can be focused down to 6 ft. The price is $399.



The Gaumont-Kalee Cross Modulation Measuring Set is designed to make test recordings and to read the degree of distortion of recorded sound for television. In this equipment a carrier frequency, obtainable at 4, 6, 7, 8 or 9 kc, is amplitude-modulated by a 400-cycle/sec frequency which is directly recorded for use in setting the level of recording and as a reference. Other frequencies also available are a 1-kc signal, useful for general testing, and a low frequency of 37-cycle/sec provided for measurement of densities. The measuring set consists of three components built into a single housing. The top panel is the cross-modulation analyzer Type 1704. The middle panel is the oscillator unit Type 1705, and the bottom panel carries the supply circuits Type 1706. The units may also be supplied separately for rack-mounting, in which case, the supply circuits would probably not be required.

Used widely in television studios throughout Great Britain, a set has been installed in the London studios of Independent Television News. A complete description of the equipment is available from Press Information Service, Rank Precision Industries, Ltd., 122 Wardour St., London W1.



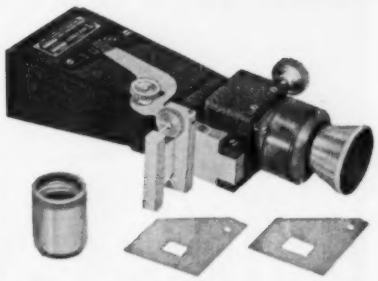
An all-metal filter designed around a permanent metallic filter element is a product of Oscar Fisher Co., Box 426, Newburgh, N.Y. Called the Fisher Microfilter, it employs the sintered metal principle. Designed for ease of installation and operation, it is connected by using standard half-inch pipe fittings and can be cleaned by momentarily reversing the flow of water. The unit is 10¼ in. high, 8½ in. long, and 4 in. wide. It is equipped with a 2–4 micron filter. Other filter cores are available. The price is $48.

A general purpose audio compressor-limiter for use where the amplitude of the original sound is greater than the useful range of the recording or broadcasting equipment has been introduced by Westrex Corp., a division of Litton Industries, 6601 Romaine St., Hollywood 38. The system consists of an RA-1593-A amplifier and RA-1594-A control unit. After initial settings are made on the control unit from a preliminary audio level test, the amplifier automatically compresses its output or chops peaks to keep the volume to within limits of the system. The amplifier consists of a three-stage push-pull program amplifier and a control amplifier. Various types of compression and limiting may be obtained by varying the d-c grid bias of two remote-cutoff pentodes in the first stage of the program circuit. Distortion is said to be less than one per cent under all conditions below peak chopping. The compression meter and operating controls are in the control unit which may be remotely located from the amplifier.

Two Servotherm preamplifier models for use with infrared radiation detectors have been announced by Servo Corp. of America, 111 New South Road, Hicksville, L.I., N.Y. These devices are for use where infrared radiations are a factor in measurement or control and are used to handle targets in motion that are fast, hot, inaccessible, or too rigid in specifications for direct contact. Descriptions and detailed specifications are contained in a bulletin, TB 1300-60, available upon request from the company.

M-H PROFESSIONAL 16mm VIEWFINDER

NOW . . . Owners of Arriflex, B & H, Bolex and Cine Special Cameras Can Shoot with Both Eyes Open



Has all the advanced features which have made this type of viewfinder the choice of Hollywod studio cameramen for TOP performance in scope and operation. Optically and mechanically precision engineered to the exacting standards of the motion picture industry requirements. An engraved aperture outline, with crosshairs in the center, shows the field of the standard 25mm lens for 16mm cameras. A border outside the actual picture area allows for anticipation of incoming scenes. A secondary magnifying lens gives an enlarged view. Mattes are provided for lenses of longer focal length and an auxiliary lens is used to cover the 15mm wide angle field.

- Large brilliant full upright image corrected from right to left. Apparent image 2" x 3".
- You shoot with both eyes open. Smooth precision focus control from two feet to infinity. Accurate parallax control calibrated on an engraved scale.
- Instant action positive lock control allows use between two or more cameras.
- Does not interfere with use of matte boxes or changing of magazines.
- Interchangeable from one camera to another in a matter of seconds. Sturdily constructed yet lightweight for ease of handling and alignment.
- Excellent illumination for dimly lit scenes.
- Auxiliary lens easily mounted for 15mm field.

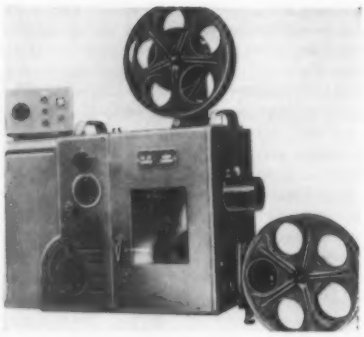
$145 INCLUDES AUXILIARY WIDE ANGLES LENS AND MATTES FOR 2 LENSES

MOUNTING BRACKETS

Arriflex, B&H 70 or Bolex H 16.....$15
Cine Special.....$ 5

S.O.S CINEMA SUPPLY CORP.

602 West 52nd Street, New York 19, N. Y.—PLaza: 7-0440—Cable: SOSound, N. Y.
Western Branch: 6331 Hollywood Boulevard, Holly'd. 28, Calif.—Phone: HO 7-2124



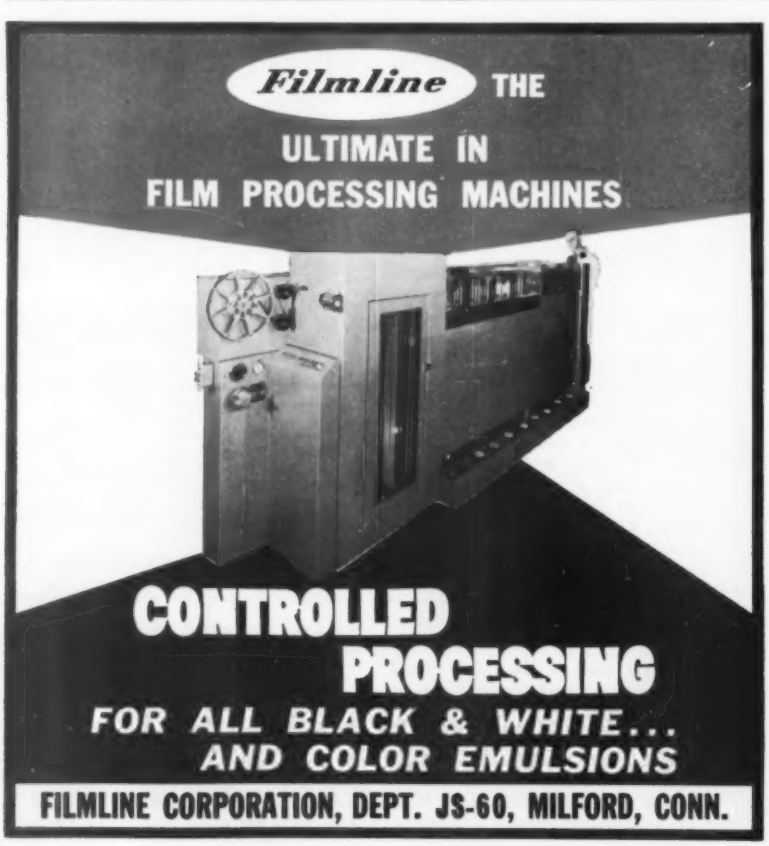
The CECO 35mm Stop Motion Projector is a product of Camera Equipment Co., 315 W. 43 St., New York 36. It is manufactured by Paromel Electronics. The projector features variable speed from 8 to 24 pictures per second in both forward and reverse operation; positive single-frame operation, forward and reverse; 1000-ft capacity reel arms; and positive frame registration, ±0.0005 in. Aperture size is 0.825 by 0.600 in. or 0.680 by 0.970 in., with additional apertures available. It has a 3½-in. *f*/1.9 lens and operates on a 110-v 50–60-cycle motor. Light projection is with a 1000-w lamp. The price is $1800.

The firm also has announced a new model of the CECO P16-S105 Weinberg-Watson 16mm Analyst Projector which can be operated by remote control. It has a variable speed from 2 to 24 frames per second in both forward and reverse and an electrically operated single-frame advance in both forward and reverse. Its price is $1695.

An ultra high frequency transistor, announced by the Lansdale Division of Philco Corp., Lansdale, Pa., is said to have a maximum frequency oscillation of close to 4000 mc. The new device is called a coaxial micro-alloy diffused-base transistor. It is priced at $125.

Five new microminiature precision resistors have been added to the line manufactured by Cinema Engineering Div., 1100 Chestnut St., Burbank, Calif. They range in size down to diameters of 0.080 in. and a length of ⅛ in. Wattage rating starts at 0.05 w to ¼ w at 125 C and derated to zero at 150 C with accuracies to 0.025%. They are described in brochure No. IC 1066 available from the company.

A compact, lightweight solenoid actuator called Type L13 Electromagnetic DC Actuator is a product of James Cunningham, Son & Co., 103 Litchfield St., Rochester 8, N.Y. The actuator utilizes a linkage system for magnifying the original air-gap movement in an 8 to 1 ratio to deliver maximum pull and stroke from small input. The unit is said to have a life of 100 million operations and to be capable of 7 msec operating time at normal voltages. It may be set for either push or pull by simply reversing the position of the arm. The maximum stroke of 0.125 in. exerts a pull of 100 to 550 grams.



These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Motion Picture Editor and Cameraman. Presently with N.E.T.R.C. Math Study Film Project at Univ. of Ill. as Head Editor and Head Cameraman. Formerly with N.O.T.S. China Lake as Cameraman and Editor. B.A. and part M.A. from Univ. of Southern Calif. Dept. of Cinema. Also experienced in motion picture laboratory, still work, and other aspects of film production. Interested in a challenging position with potential. Write or telephone for resume or Form 57; day: EMpire 7-6611, ext. 3837; night: EMpire 5-1038; Stanley Follis, 1311 South Cottage Grove, Urbana, Ill.

Sound Engineer. Young Indian desires position as sound engineer in a well-established organization. Brilliant academic career. Graduate in Science. Three years Diploma in Sound Engineering. Well versed in equipment maintenance and procedures and motion-picture laboratory practice. Enterprising and hard-working. Prepared to work as 'Apprentice Trainee', if desired. Member of Audio Engineering and Associate Member of SMPTE. Write: M. K. Srivatsa, 17, Rangarao Road, Shankarapura, Bangalore-4, India.

Trainee. Israeli student, 31, motion pictures graduate UCLA '60, speaks 7 languages, with rich background in public relations, needs opportunity for practical training in any phase of cinematography or television production. Will travel. New York or Los Angeles areas preferred. Write P.O. Box 24533, Los Angeles 24.

Writer-Director. Experienced in production of technical, educational, training and promotional films. Background includes editing, camera and sound. Experienced in military electronics field. Desires position with unit actively engaged in production. Married, BA degree, willing to relocate. Write: Film Director, 4813 "B" St., Philadelphia 20, Pa.

Producer-Director. Winner of national awards. Currently employed, but desirous of obtaining challenging position where hard work, enthusiasm and ability are needed. Experienced in all phases of production. Capable of handling crews and supervising production from script to screen. Background in industrial and educational films. College cinema grad. Write: Producer, 3100 Kelton Ave., Los Angeles 34, Calif.

Motion-Picture Engineer. B.Sc. Elect. Eng., 15 yrs experience all engineering phases motion-picture production and services, mainly sound recording. Administrative and management experience as well as complete layout, design, installation, operation and maintenance of two sound recording studios. Fellow SMPTE, member of Sound Committee. Age 38, married, fully bi-lingual, French and English, would relocate. R. J. Beaudry, 9 Badger Dr., Toronto 18, Ont., Canada.

Writer-Producer. Young man, 27, with college background in documentary film production. Have written and produced business and training films with top Chicago studio and educational films for largest studio in the field. Desire position with film producer anywhere in U.S.A. or abroad. Write B.K., 820 W. 79th St., Chicago 20, Ill.

Cameraman. Presently employed shooting special photographic effects, miniatures, inserts, mattes, rear projection, and stop-motion animation for a special-effects company. Have experience with black-and-white, Ektachrome and Eastman Color, also CinemaScope, on feature films, TV commercials, TV series and industrials. Employed 2 years on TV series as dimensional animator, later as production manager on same cartoon series. Also experienced with editing and A & B roll cutting. USC degree. Age 28, single. Desire position with educational, commercial or industrial film company. Resume on request. R. Rodine, 5636 Laurel Canyon Blvd., North Hollywood, Calif. POplar 1-0728.

Cinematographer. Motion-picture or visual aids specialist. 1960 grad. Univ. Calif., B.A. in motion pictures. U.S. citizen, born and raised in Germany. Two languages fluently. One yr professional experience as director photog. with TV advertising agency in 16mm motion-picture and TV slide-film production. Serious student cinema since age 12. Also experienced sound recording and as projectionist, 16 & 35-mm. Interested in career job, technical and creative end theatrical or industrial film production. Age 31. Prefer U.S. but free to travel. Member SMPTE and IATSE. Write: Dieter W. Kaisenberg, P.O. Box 1142, Hollywood 28.

Electro-Mechanical-Optical Engineer. Graduate, 10 yrs experience in development, research and design of precision instruments. Presently employed as supervisory engineer. Optical patent currently being processed. Attending evening graduate physics courses. Desire challenging work in optical instrumentation and/or design; will consider related work. Resume and references upon request. Harry Silver, 65-61 Parsons Blvd., Flushing 65, N.Y. OL 8-0133.

Educational TV and Motion-Picture Administrator and Consultant. Experienced in every phase of ETV administration, programming, production and teaching, open and closed circuits. Also broad background in mass communications; Ph.D. Consultant on design and use of TV and film equipment, communications curricula, instruction by and for TV. Design of studios, either new building or revamping any size present space. Box 1143, Jacksonville Beach, Fla. CHerry 6-2269.

Writer, Director, Cameraman available for special Civil War Centennial projects. 14 yrs experience in all phases motion-picture and TV work. Writing credits in national magazines, trade journals and films. Know and have written on Civil War subjects and locations. Will handle assignments for producers working on films or presentations for upcoming Centennial Celebration. Write R. Krepela, P.O. Box 7331, Atlanta 9, Ga.

Positions Available

Motion - Picture Production Salesmen. Excellent opportunity for men in all corners of the world to affiliate themselves with a new motion - picture production unit. Salesmen should have contacts in industry, public relations and advertising fields to sell motion-picture and film-strip productions. Write giving full details of area you can cover. Allegro Film Productions, 723 Seventh Ave., New York 19.

Sales Manager/Sound Studio. To develop and carry out sales-marketing program to sell sound recording service to film producers, advertising agencies and broadcasters. Technical background in recording techniques plus understanding and know-how as to sound problems of users required. Special emphasis on video tape services. Send resume and salary requirements in full confidence to W. P. Fiske, 1 East Putman Ave., Greenwich, Conn.

Film Inspectors, Film Librarian. Temporary or permanent. Write or call Peerless Film Processing Corp., 165 W. 46 St., N. Y. 36 Tel. PLaza 7-3630. Att: Kern Moyse.

Sales Engineers. For electronic equipment, closed-circuit TV, etc., in districts of Boston and Chicago. Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N. J. CEnter 9-6100.

Motion-Picture Timer. Experienced technician for color filmstrip laboratory. Excellent opportunity for man with aptitude to join growing organization. Duties involve negative handling, color timing, control of tests, answer prints and production. Some knowledge of camera work and animation helpful. Reply confidentially to: M.G., 68-46 Groton St., Forest Hills 75, N.Y.

Motion-Picture Production Worker. Opening exists for talented motion-picture and filmstrip production worker in educational organization located Tidewater, Virginia. Required would be good smattering of experience and comprehension of all elements of creative writing, some motion-picture camera work, supervision of filmstrip production and participation in many phases of motion picture production. Quality of work rather than quantity is considered most important. Permanent position, liberal benefits including group hospitalization, life insurance, free medical service, free retirement. Send complete résumé to James A. Fuller, Director of Employment Colonial Williamsburg, Williamsburg, Va.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Complete set of Journals from January 1934 through June 1960. Excellent condition. For sale only as a set. Write: Don Norwood, 1470 San Pasqual St., Pasadena, Calif.

For Additional Listings of Journals Available, see p. 392, May 1960 *Journal*.

Wanted

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.

Transactions 6 and 9 ($15 each offered). W. W. Hennessey, RFD #2, Pound Ridge, N.Y.

Jan. 1938, Jan. 1949. (Many other issues are available for trade.) Dept. of Cinema, Univ. of Southern Calif., University Park, Los Angeles 7. Att: Herbert E. Farmer.

Transactions No. 1, 1916 ($5 offered); No. 6, 1918 ($10 offered); No. 7, 1918 ($10 offered). James G. Barrick, 15726 Fernway Ave., N.W., Cleveland 11, Ohio.

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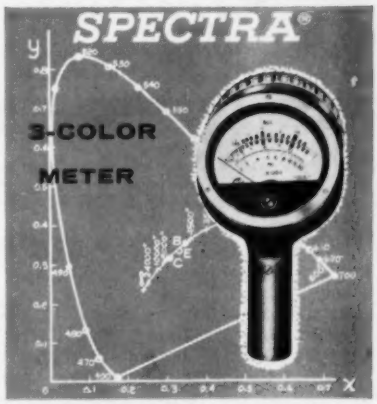

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Meeting Calendar

Western Electronic Show and Convention, Aug. 23–26, Los Angeles.
Electron Microscope Society of America, Annual Meeting, Aug. 29–31, Marquette Univ., Milwaukee, Mich.
European Conference on Electron Microscopy, Aug. 29–Sept. 3, 1960, Delft, Netherlands.
Standards Engineers Society, Sept., Pittsburgh, Pa.
Illuminating Engineering Society, National Technical Conference, Sept. 11–16, Penn Sheraton Hotel, Pittsburgh, Pa.
International Scientific Film Association, 14th Congress, Sept. 16–24, Prague, Czechoslovakia.
Deutsche Gesellschaft für Photographie, 1st International Congress on Medical Photography and Cinematography, Sept. 27–30, Düsseldorf, Germany.
International Center of Photography Congress, Sept. 27 – Oct. 1, Florence, Italy.
Armour Research Foundation & IRE, 6th Conference on Radio-Interference Reduction and Electronic Compatibility, Oct. 4–6, Museum of Science and Industry, Chicago.
ASCE, National Convention, Oct. 9–13, Boston, Mass.
Electrochemical Society, Meeting, Oct. 9–13, Shamrock Hotel, Houston, Texas.
AIEE Fall General Meeting, Oct. 9–14, Chicago.
NEC National Electronics Conference, Oct. 10–12, 1960, Hotel Sherman, Chicago.
Optical Society of America, Annual Meeting, Oct. 13–15, Somerset Hotel, Boston, Mass.
Fifth International High-Speed Congress and Equipment Exhibit, sponsored by the SMPTE, Oct. 16–22, 1960, Sheraton-Park Hotel, Washington, D.C.
Symposium on Space Navigation, Oct. 19–21, 1960, Columbus, Ohio.
Acoustical Society of America, Fall Meeting, Oct. 20–22, San Francisco.
ISA, AIEE, IRE, Sponsors, 13th Annual Conference on Electrical Techniques in Medicine and Biology, Oct. 31–Nov. 2, Sheraton-Park Hotel, Washington, D. C.
AIEE, API, ONR, IRE, Metallurgical Society, Sixth Annual Conference on Magnetism and Magnetic Materials, Nov. 14–17, New Yorker Hotel, New York.
ASME, Annual Meeting, Nov. 27–Dec. 2, Statler Hilton Hotel, New York.
American Association for the Advancement of Science, Annual Meeting, Dec. 26–31, New York.
ISA, Winter Instrument-Automation Conference and Exhibit, Jan. 16–19, 1961, Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.
IRE International Convention, Mar. 20–23, 1961, New York Coliseum, New York.
ISA, 7th National Symposium on Instrument Methods of Analysis, Apr. 17–19, 1961, Shamrock-Hilton Hotel, Houston, Texas.
89th Semiannual Convention of the SMPTE, May 7–12, 1961, King Edward Sheraton, Toronto.
90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N.Y.
91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962, Ambassador Hotel, Los Angeles.
92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.
93d Semiannual Convention of the SMPTE, Apr. 22–26, 1963, Traymore Hotel, Atlantic City, N. J.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1960 Journal Part II.

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